

6-1926

# Soil Survey of Iowa, Report No. 42—Jasper County Soils

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# **SOIL SURVEY OF IOWA**

## **JASPER COUNTY**

**AGRICULTURAL EXPERIMENT STATION  
IOWA STATE COLLEGE OF AGRICULTURE  
AND MECHANIC ARTS**

**Agronomy Section  
Soils**



**Soil Survey Report No. 42  
July, 1926  
Ames, Iowa**



# IOWA AGRICULTURAL EXPERIMENT STATION

(Those followed by a \* are out of print, but are often available in public libraries.)

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95 The Maintenance of Fertility with Special Reference to the Missouri Loess.\*  
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- 1 The Chemical Nature of the Organic Nitrogen in the Soil.\*  
2 Some Bacteriological Effects of Liming.\*  
3 Influences of Various Factors on the Decomposition of Soil Organic Matter.\*  
4 Bacterial Activities in Frozen Soils.\*  
5 Bacteriological Studies of Field Soils, I.\*  
6 Bacteriological Studies of Field Soils, II.\*  
8 Bacteria at Different Depths in Some Typical Iowa Soils.\*  
9 Amino Acid and Acid Amides as Source of Ammonia in Soils.\*  
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June, 1926

Soil Survey Report No. 42

# SOIL SURVEY OF IOWA

## Report No. 42--JASPER COUNTY SOILS

By W. H. Stevenson and P. E. Brown, with the assistance of D. S. Gray, A. M. O'Neal,  
L. W. Forman, J. L. Boatman and Bryan Boatman

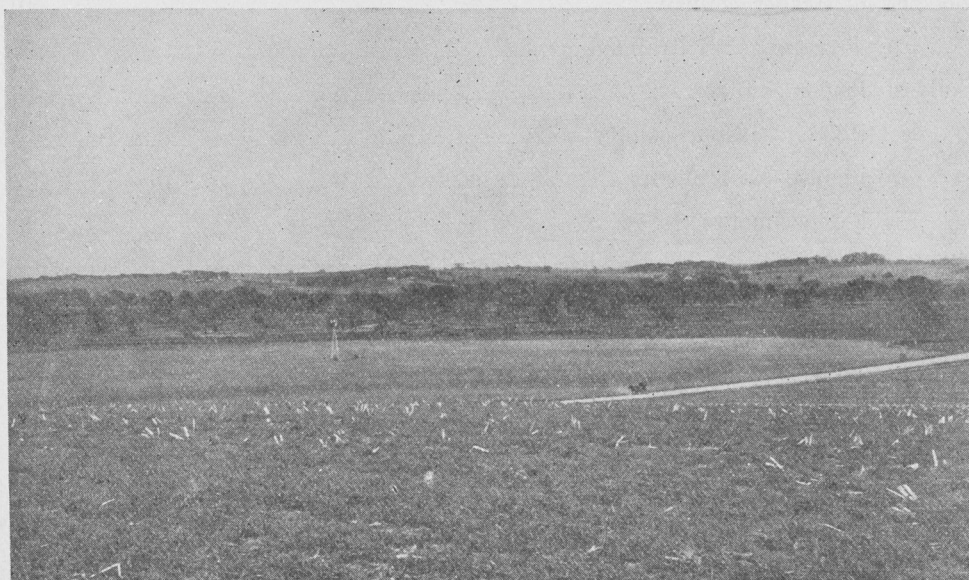


Fig. 1. Wabash bottoms, Clinton silt loam in background.

IOWA AGRICULTURAL  
EXPERIMENT STATION

C. F. Curtiss, Director  
Ames, Iowa

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# JASPER COUNTY SOILS\*

BY W. H. STEVENSON AND P. E. BROWN WITH THE ASSISTANCE OF D. S. GRAY, A. M. O'NEAL,  
L. W. FORMAN, J. L. BOATMAN AND BRYAN BOATMAN.

Jasper County is located in central Iowa in the fourth tier of counties north of the Missouri state line and in the fifth tier west of the Mississippi River. It lies mainly in the Mississippi loess soil area. A small part of the county, however, is covered by soils derived from the Southern Iowa loess and from the Wisconsin drift. By far the largest portion of the soils of the county are of loessial origin.

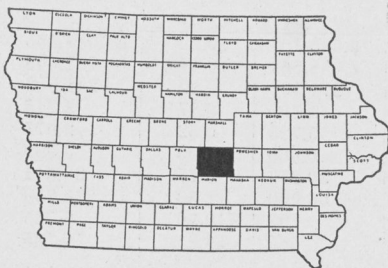


Fig. 2. A map showing the location of Jasper County.

The total area of the county is 730 square miles or 467,200 acres. Of this area, 446,345 acres or 95.5 percent is in farm land. The total number of farms is 2,903 and the average size of the farms is 154 acres. The farms are operated by 1,617 owners, 376

relative renters, 712 renters, 179 classified as both owning and renting and 19 unclassified. The following figures from the Iowa Yearbook of Agriculture for 1923 show the utilization of the farm land of the county.

Acreage in general farm crops .....	269,356
Acreage in farm buildings, public highways, and feed lots.....	20,438
Acreage in farm woodlots used for timber only.....	705
Acreage in waste land not utilized for any purpose.....	2,528
Acreage in orchards .....	997
Acreage in crops not otherwise listed.....	191
Acreage in pasture .....	150,853

## THE TYPE OF AGRICULTURE IN JASPER COUNTY

The type of agriculture followed in Jasper County at present consists mainly of a system of general farming which includes the growing and sale of grain crops and the raising and feeding of livestock. On many farms, however, all or nearly all of the crops grown are sold. It is generally recognized that a system which provides for the utilization of a large portion of the crops grown for feeding purposes on the farm is the most profitable from the standpoint of farm income as well as from the standpoint of the maintenance of the fertility of the soil. The system of general farming or mixed farming is rapidly becoming the common practice over the entire county.

The raising of truck crops and fruit crops is not important altho practically all farms produce some fruit and vegetables for home consumption. The leading cash crops are corn and wheat. Probably less than one-fourth of the corn produced in the county is sold to local elevators and shipped out. On tenant farms a greater proportion of the crop is marketed than on those which are operated by owners. Wheat serves as a minor cash crop altho

\*See Soil Survey of Jasper County, Iowa, by D. S. Gray and A. M. O'Neal of the Iowa Agricultural Experiment Station and R. E. Devereux and S. B. Cole, of the U. S. Department of Agriculture. Field operations of the Bureau of Soils, 1921.

in some parts of the county it is grown rather extensively. The raising and feeding of hogs, cattle and sheep are important livestock industries and provide the major source of farm income in the county. The raising of hogs is probably the most important. The raising of beef cattle, however, is prac-

TABLE I. AVERAGE YIELD AND VALUE OF CROPS GROWN IN JASPER COUNTY, IOWA\*

Crop	Acreage	Percent of total farm land of county	Bushels or tons per acre	Total bushels or tons	Average price	Total value of crop
Corn .....	151,469	33.93	43.0	6,513,167	\$0.62	\$4,038,163
Oats .....	60,546	13.56	34.0	2,058,564	0.37	761,668
Winter wheat .....	13,590	3.04	20.0	271,800	0.89	241,902
Spring wheat .....	287	0.06	15.0	4,305	0.87	3,745
Barley .....	229	0.05	25.0	5,725	0.52	2,977
Rye .....	303	0.06	20.0	6,060	0.66	3,999
Potatoes .....	387	0.08	79.0	30,573	0.77	23,541
Tame hay .....	41,813	9.36	1.6	66,900	12.50	836,250
Wild hay .....	496	0.11	1.6	793	10.50	8,325
Alfalfa .....	236	0.05	2.8	660	16.25	10,725
Pasture .....	150,853	33.79	....	.....	.....	.....

\*Iowa Yearbook of Agriculture, 1923.

ticed very extensively and many are shipped in for feeding. Dairying is practiced to some extent but is not an important industry.

The acreage of waste land in Jasper County is rather large. It seems quite important that some methods be adopted for the treatment of such areas so that the land may be made productive. General recommendations for the management of such areas cannot be given because the infertility is produced by various causes and the same treatment will not serve for all conditions. Later in this report, treatments which are desirable for use under special soil conditions will be suggested. Where the conditions are more or less abnormal, farmers may secure advice regarding the treatment of their soils by corresponding with the Soils Section of the Iowa Agricultural Experiment Station.

#### GENERAL FARM CROPS GROWN IN JASPER COUNTY

The general farm crops grown in Jasper County in the order of their importance are: corn, oats, hay, wheat, potatoes, alfalfa, rye, barley. Average yields and value of these crops grown in the county are given in table I.

Corn is by far the leading crop in the county both in acreage and value. In 1923, it was grown on 33.93 percent of the total farm land of the county. Average yields of the crop amount to 43 bushels per acre. The chief variety grown is Reid's Yellow Dent. Some white corn, some calico and red corn and some yellow corn of no definite variety are grown to a small extent in the county. It is estimated that over half of the corn produced is fed on the farms, some being sold to other farmers in the county for feeding purposes and probably less than one-fourth is sold out of the area. The practice of hogging-down the corn with the hogs or cattle is practiced to a considerable extent. Occasionally soybeans or cowpeas are seeded with the



corn. Some of the corn is utilized for silage. In 1923 there were 386 silos in the county and a production of 19,553 tons of silage.

The oats crop is the second in acreage in the county and the third in value of the crop. In 1923 it occupied 13.56 percent of the farm land of the county. Average yields amounted to 34 bushels per acre. The most popular varieties include Kherson, Early Champion, Iowa 103 and Iowa 105. The oats crop is used mainly as feed for work stock on the farms and a small part is frequently sold.

The hay crop is second in value to corn and occupies the third largest area. In 1923 tame hay was grown on 9.36 percent of the total farm land of the county. A very small acreage is in wild hay and a still smaller area in alfalfa. The yield of tame hay amounted to 1.6 tons per acre. Timothy and clover mixed is the most commonly grown tame hay crop. Some clover is grown alone and some timothy is grown alone. Both of these crops are occasionally grown for seed. In 1923 there was 1,073 acres in timothy utilized for seed with the production of 5,018 bushels; 2,449 acres were in clover which was grown for seed, with a production of 4,317 bushels. Practically all of the hay grown in the county is utilized locally for feeding purposes. The amount of wild hay produced in the county is small and the crop is of little value. Wild hay is grown mainly on the areas of bottomland which are not suitable for cultivation and on some of the areas of rough land in the uplands or depressed poorly drained spots. Bluegrass provides the chief crop for the permanent pastures.

Alfalfa is grown to only a small extent in the county but it is an extremely profitable crop. Yields of 2.8 tons per acre are reported. With proper care in preparing the soil for this crop, the use of good seed and favorable seasonal conditions, very satisfactory stands of alfalfa should quite readily be secured. It is particularly important that soils should be tested for acidity and that lime be applied if alfalfa is to be grown successfully. Larger areas utilized for this crop in the county would undoubtedly mean greater farm income on most farms.

Wheat is the fourth crop in acreage and value in the county. Winter wheat is grown rather extensively. There is only a very small acreage in spring wheat. In 1923, winter wheat was grown on over 3 percent of the total farm land of the county. Average yields of the crop amounted to 20 bushels per acre. Turkey is the principal winter variety while Marquis and Java are the chief spring varieties grown. Wheat is a cash crop on the farms and is disposed of at the local elevators from which it is shipped to Chicago.

Potatoes, barley, rye, buckwheat, sorghum and various vegetable crops are of minor importance in Jasper County. The yield of potatoes is estimated at 79 bushels per acre, barley at 25 bushels and rye at 20 bushels per acre. The total area devoted to vegetable crops in the county is rather small. Small quantities of garden truck are grown near Newton and watermelons and cantaloupes are produced on the sandy soils, especially in the vicinity of Colfax. These are sold at the local markets or in Newton or Des Moines.

Fruit growing is practiced to some extent in Jasper County but not on a commercial scale. The fruit grown consists mainly of apples with some

cherries, plums, peaches and pears. Most farms maintain a small orchard and raise a few apples. The fruit produced is consumed on the farms, however, in practically all cases. Some strawberries, raspberries, blackberries and grapes are grown on most farms on a small scale chiefly to supply the home demand.

#### JASPER COUNTY'S LIVESTOCK INDUSTRY

The livestock industry of Jasper County includes the feeding and breeding of hogs, cattle, horses and sheep. The following figures from the Iowa Yearbook of Agriculture for 1923 show the extent of the livestock industry in the county:

Horses, all ages .....	15,806
Mules, all ages .....	1,444
Swine on the farms July 1, 1923 .....	199,861
Swine on the farms January 1, 1924 .....	163,994
Cattle, cows and heifers kept for milk.....	12,113
Cattle, other cattle not kept for milk.....	50,024
Cattle, total all ages, January 1, 1924.....	62,137
Sheep, all ages on the farms, January 1, 1924.....	12,716
Sheep, shipped in for feeding, 1923.....	8,959
Sheep, total pounds of wool clipped.....	66,064
Poultry, total all varieties January 1, 1924.....	439,066
Poultry, number dozen eggs received 1923.....	1,739,528

The raising of hogs is undoubtedly the most important livestock industry. The number on the farms Jan. 1, 1924, was 163,994. The most popular breed is the Poland China, followed closely by the Duroc Jersey. At the time of the survey in 1921, there were 23 herds of purebred Poland China hogs registered by the County Farm Bureau, 22 herds of purebred Duroc Jersey, 9 purebred herds of Hampshire, 7 of Chester White and 7 of Spotted Poland China. There are undoubtedly many other herds of purebred hogs in the county which were not listed by the Farm Bureau. Besides the purebred herds there are many grade hogs raised in the county. The raising of purebreds for sale as breeding stock is practiced to some extent. The feeding industry, however, is most extensively developed and provides the chief income on the farms. The hogs are marketed in the spring and fall, largely on the Chicago market.

The breeding and feeding of beef cattle is quite as important as hog raising in the county. On Jan. 1, 1924, the total number of cattle of all ages on the farms was 62,137. There are many herds of purebred stock in the county. The Farm Bureau listed in 1921, 40 herds of purebred Shorthorns, 18 of Aberdeen Angus, 18 of Herefords and 7 of Polled Herefords. Many cattle are shipped in each year for feeding purposes. The feeder stock consists mainly of western range cattle bought on the Omaha and Kansas City markets. They are disposed of generally in Chicago. The sale of the cattle as well as of the hogs is handled mainly by cooperative livestock associations of which there were 14 in the county at the time of the survey. There are a few farmers in the county who specialize in the production of breeding stock.

The dairy industry is not developed to any large extent in the county. In 1923, there were 12,113 dairy animals in the county. According to the records of the Farm Bureau, there were in 1921, 6 herds of purebred Holsteins and 1 of Jerseys. There are undoubtedly more purebred dairy herds

than this in the county. Milk cows are kept on practically all farms to supply the home needs and they are generally grades. The dairy products are usually sold locally and in the nearby towns.

The raising and feeding of sheep is of some importance in Jasper County. On Jan. 1, 1924, there were 12,716 sheep on the farms. The total number of sheep shipped in for feeding in 1923 was 8,959 and the total pounds of wool clipped in 1923 amounted to 66,064. There are several flocks of purebred sheep in the county. Some sheep are shipped in, largely from Kansas City and Omaha, for feeding purposes. The wool produced is marketed largely thru the Iowa Fleece Wool Growers' Association.

The raising of horses and mules is practiced to a small extent in the county, most farmers raising a colt or two each season. Some farmers make a specialty of raising breeding stock. The Percheron is the most popular breed of horses, followed by the Clydesdale and Shire. There are also a large number of Belgian horses in the county. Some mules are raised on a few farms.

The poultry industry is of considerable importance in the county. In 1923, there were 1,739,528 dozen eggs received. The total number of poultry on the farms Jan. 1, 1924, was 439,066. The value of the poultry products produced in the county is considerable and there is rather a large sale of these products to the outside markets.

The value of the land in Jasper County is quite variable, depending on the location with reference to the towns and to railroad facilities, the improvements on the farm and the general soil conditions. In 1921, the values were given as ranging from \$50 to \$350 per acre. This was at the period of high prices. There is some low priced land in the county but in general the land is of considerable value and will average around \$200 per acre.

#### THE FERTILITY SITUATION IN JASPER COUNTY

General farm crops usually give quite satisfactory yields in Jasper County but proper methods of soil treatment will undoubtedly bring about larger crops in many cases. Different soils will respond differently to treatment, depending upon the particular conditions and upon the crop which is grown, but there are certain general recommendations which can be made for the handling of the soils of the county, which will undoubtedly improve the growth of crops.

In some areas in the county the drainage conditions are not satisfactory and the soils are frequently too wet for the best growth of farm crops. When this condition occurs the first treatment needed by these soils to make them satisfactorily productive is the installation of tile. It is useless to attempt to increase crop yields on such areas by fertilizer treatments until the drainage has been made adequate.

Practically all the soils of the county are acid in reaction and hence in need of lime. If the best growth of general farm crops and particularly of legumes, such as red clover and alfalfa, is to be secured the addition of lime to acid soils is necessary. Only one of the soil types in the county, the Webster silty clay loam, has any large content of lime in the surface soil.



Hence all the other types should be tested for lime requirement. In a few cases there is a considerable occurrence of lime in the subsoil of the type but this does not obviate the need of additions if the surface soil is acid. The only way to determine the actual need of the soil for lime is by testing it for acidity. Then the proper application may be made.

The supply of organic matter in the soils of the county is fairly adequate on most of the types but there are areas where the soils are not very well supplied, where the color is not so dark and where the crop growth is not entirely satisfactory. Applications of farm manure will prove of very large value on practically all of the types in the county. Even on those soils which are better supplied with organic matter and black in color, the addition of farm manure brings about very large crop increases. On the soils which are more poorly supplied and lighter in color, liberal applications of farm manure will show particularly large effects. Experimental work and much farm experience have shown very definite indications of value from the application of farm manure. The use of leguminous crops as green manures may be of considerable value on many of the types. The practice of green manuring is especially necessary on light colored sandy soils but it may also be followed to advantage on many other types. The practice is necessary on grain farms where little or no farm manure is produced but it may also prove of considerable value on livestock farms where the supply of manure is inadequate to keep up the content of organic matter in all the soils.

In many cases the content of nitrogen in the soils of the county is not entirely adequate and the application of some fertilizing material containing nitrogen is very desirable. On all the soils of the county care must be taken to insure the maintenance of the nitrogen content. In all cases the supply of nitrogen in the soils may be built up and maintained thru the proper use of leguminous crops as green manures. This practice serves to supplement the use of farm manure in many cases as a means of maintaining the nitrogen supply.

The phosphorus content of the soils of the county is low and phosphorus fertilizers will certainly be needed in the county in the very near future. It seems, however, from the experiments which are reported later and from some farm experience that applications of a phosphate fertilizer would be very desirable in many cases at the present time. Definite recommendations regarding the use of acid phosphate or rock phosphate cannot yet be definitely given inasmuch as the results secured have been quite variable. It is recommended, therefore, that tests be carried out on individual farms, using both acid phosphate and rock phosphate. In this way farmers may determine whether or not their soils will respond to phosphorus and they may also determine which fertilizer may be used with greater value.

Complete commercial fertilizers are not recommended for general use in the county at the present time. The tests which have been carried out with these materials have not indicated any larger value from their use than from the application of acid phosphate. It would seem, therefore, that the latter material would be preferable for application to the soils of the county inasmuch as it is less expensive. Farmers who are interested may test com-



# SOIL MAP OF JASPER COUNTY, IOWA

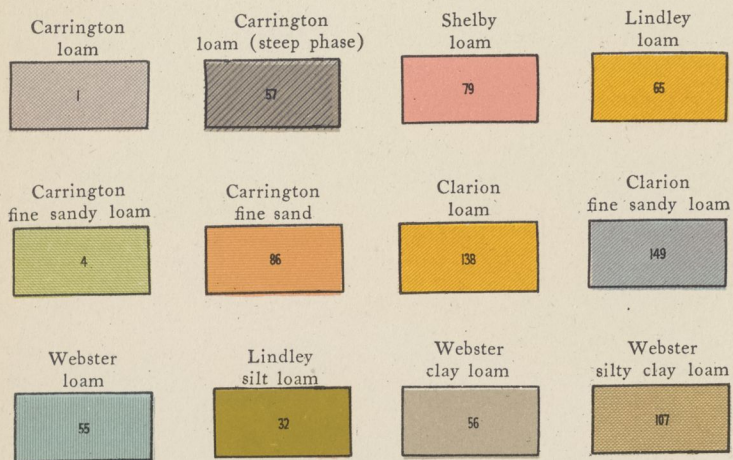
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C. F. Curtiss, Director. W. H. Stevenson, in charge Soil Survey  
P. E. Brown, Associate in charge.

Thomas D. Rice, Inspector Northern Division  
Soils surveyed by D. S. Gray, in charge and A. M. O'Neal, Iowa Agricultural  
Experiment Station and S. Cole and R. E. Devereux,  
U. S. Dept. Agriculture.

U. S. DEPT. OF AGRICULTURE, BUREAU OF SOILS  
Milton Whitney, Chief. Curtiss F. Marbut, in charge of Soil Survey

## LEND

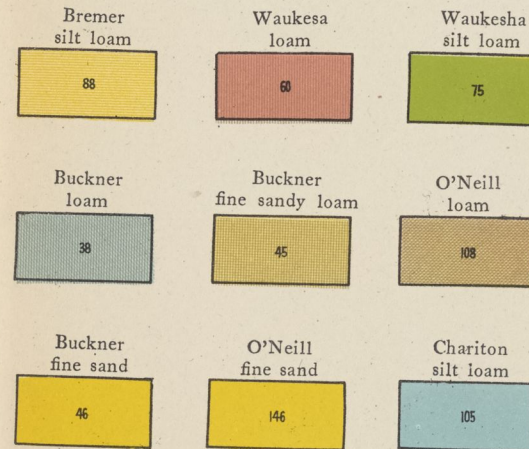
### Drift Soils



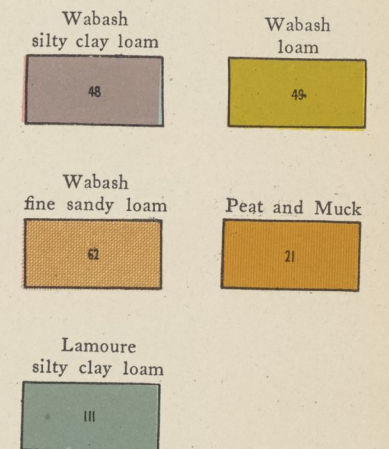
### Loess Soils



### Terrace Soils

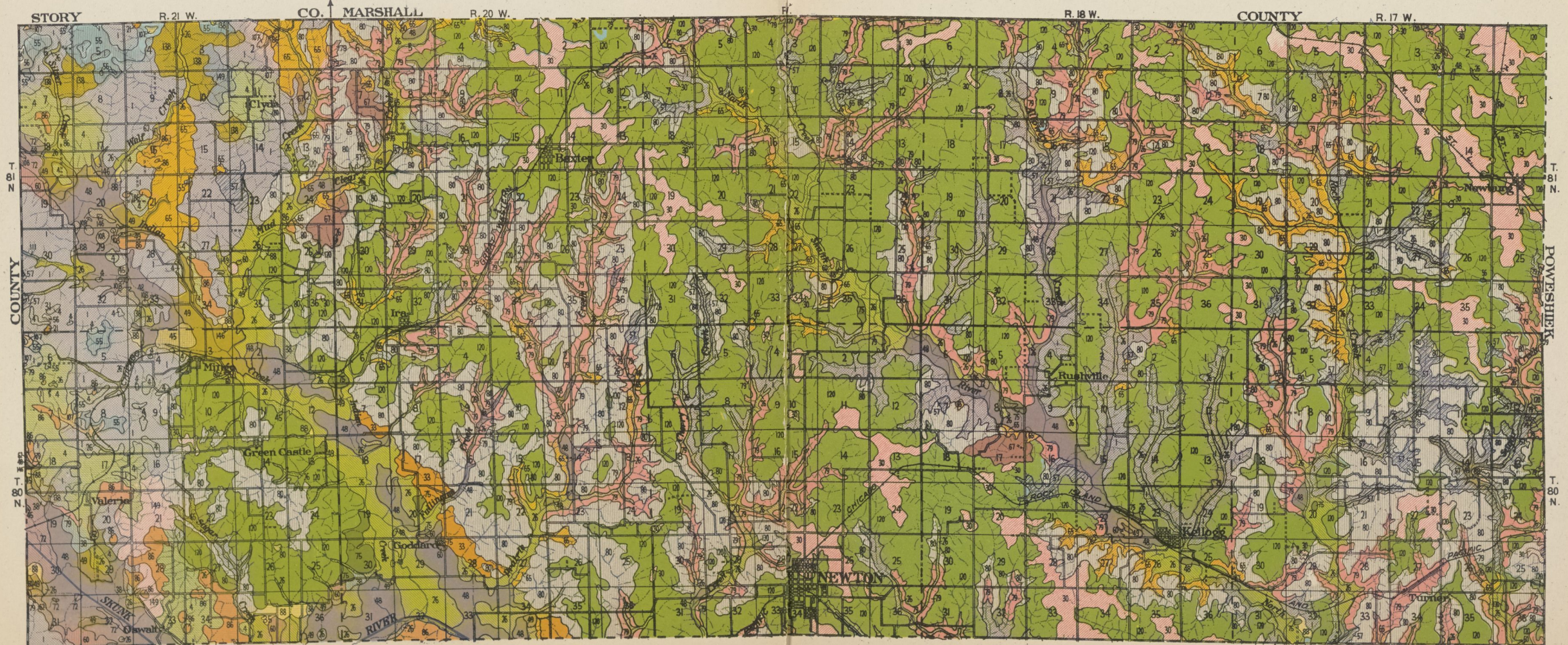


### Swamp and Bottomland Soils



The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

Scale: 1 Inch 2 1/2 Miles





plete fertilizers, however, on their own soils in comparison with a phosphate fertilizer and thus determine the actual value under their particular conditions. Commercial nitrogenous fertilizers are not recommended at the present time and it is believed that the nitrogen content of the soils may be maintained more cheaply and quite as satisfactorily by the utilization of leguminous crops as green manures. Commercial potassium fertilizers may prove of value in some cases but such materials should not be used until tests have been carried out on a small scale to determine their value. The soils of the county are very well supplied with potassium and the use of a commercial potassium fertilizer would be of value only in that it would supply potassium immediately available for plant use. If any of these commercial fertilizers prove of profit when tested on individual farms, however, there is no objection to their use.

There is considerable erosion in some parts of the county and some of the soils have been very badly washed by this destructive action. The surface soil has frequently been washed away in large part and there are very often gully formations which are extremely injurious to the proper utilization of the land. It is very desirable that some methods be adopted to prevent or control the washing away of surface soil and the development of gullies. Suggestions are offered later in this report for the control and prevention of erosion. From among them, some method may be chosen which will fit in with almost any farm conditions.

## THE GEOLOGY OF JASPER COUNTY

It is unnecessary to consider the geological history of Jasper County in detail inasmuch as the earlier geological formations have no effect whatever upon present day soil conditions. The soils of the county are derived entirely from the glacial and loessial deposits made in the later geological ages. The native rock materials underlying these deposits are so deeply buried that they have no effect whatever upon the characteristics of the soil.

During the glacial age at least two great glaciers invaded the county and each time upon their retreat an enormous mass of glacial drift or till was left behind over the surface of the land. The earlier topographic characteristics of the surface of the county were largely obliterated by the first ice sheet. The action of the later glaciers remodeled extensively the topographic features which developed in the earlier drift deposits and laid down over them new and deeper layers of drift. The deposits of drift material in the county are therefore variable in depth.

The earliest drift deposit, known as the Kansan, covers the entire surface of the county. The depth of the deposit is extremely variable, ranging from a few feet in some areas to as much as a hundred feet in other places. Underlying this drift deposit there are, in many places, layers of sand and gravel containing pebbles and small boulders. The Kansan drift deposit is typically a blue boulder clay. When exposed to weathering, however, oxidation has occurred and the color has changed to a bright yellow or deep reddish-brown. Pockets of sand and gravel often occur in this deposit and boulders are frequently found. The Lindley soils are the only types which are derived in any part from the Kansan deposits. They consist of Kansan material with a loessial covering.

At a much later date a second glacier, the Wisconsin, invaded and crossed the northwestern corner of the county. The deposit left by this glacier consisted of a blue boulder clay, less impervious, however, than the Kansan material. In the upper part of this drift deposit, weathering has occurred and the color has changed to a dull yellow. Boulders occur commonly thru the drift and in many places it is high in content of carbonates and effervesces when tested with acid. Several of the soil types developed in the western part of the county are developed from this Wisconsin drift deposit. The soils of the Carrington, Clarion, Webster and Shelby series are of Wisconsin drift origin.

Following the glacial age there was a deposition of fine silt-like material known as loess over practically all of the surface of the county except the northwestern corner where the Wisconsin drift soils are developed. The deposition was made presumably by the wind at some time when climatic conditions were very different than at present. The layer of loess is extremely variable in depth, ranging from a few inches to 20 or 30 feet. It was laid down somewhat uniformly over the previous topographic features of the county and the variations in depth at the present time are probably due to the erosion which has occurred since deposition.

In its unweathered condition, loess is an even-grained silty material, ranging in color from a light grayish-brown to a yellowish-brown. Since it was deposited it has been subjected to weathering and the accumulation of organic matter and there has been a considerable change in color. It is now ordinarily quite dark, ranging from a buff color to a dark brown to black in the different soil types. Under prairie conditions there has been a more abundant plant growth and more accumulation of plant residues and the soils are darker in color. The Muscatine and Tama soils are derived from the loessial material that developed under prairie conditions and hence they

are dark in color. The Grundy types are also formed under these conditions and they are dark in color. Where the weathering of the loess has taken place under wooded conditions, considerable leaching has occurred. There has been less accumulation of organic matter and the soils are lighter in color. The types developed under these conditions include the soils of the Clinton series, the Knox series and the Marion series. Where erosion has occurred to a considerable extent and there has been a large removal of the loessial covering, the soils of the Lindley series are developed. These are composed of loess at the surface but the underlying material at varying depths is of glacial or drift origin.

The terrace and bottomland soils in the county are partly of glacial origin and partly of drift origin. They are mainly derived from the loessial material, however, as the uplands of the county are so largely composed of loess. Only in the northwestern part where the uplands are of drift origin are the terraces and bottoms to any large extent of glacial origin. In many areas these types on the lowlands are a mixture of glacial and loessial material.

#### PHYSIOGRAPHY AND DRAINAGE

In topography Jasper County is mainly rolling to strongly rolling. This is the general topography of the loess covered uplands which extend over the major portion of the county. The surface of the Kansan drift deposit over the county was probably fairly level when the loess was laid down. Destructive erosion has occurred, however, since the deposition of the loess and the action of streams and the washing of water has brought about a modification in the topographic features. Evidence of the earlier level plain may be seen in the long irregular rather flat areas which are found between the main streams of the county. These more level areas correspond roughly with the areas mapped as Muscatine silt loam. There are narrow strips of more broken land along the deeper stream valleys but in general the topography is definitely gently rolling and the loess covering probably obliterated to a considerable extent the few topographic features which had developed in the Kansan drift deposit. In several places along the Skunk River there are sand hills and ridges which form a prominent topographic feature. In the northwestern corner of the county where the more recent Wisconsin drift has been deposited, the topography is generally smooth to level and there are marshy areas and occasional ponds, characteristic topographic features of Wisconsin drift soils.

Terraces or second bottomlands occur extensively along the streams of the county, usually from 5 to 20 feet above overflow. The areas of these soils are flat to sloping in topography. The bottomlands are found along the larger streams and their tributaries and in topography they are flat to sloping and in some places the topography is undulating to billowy, because of the presence of old stream courses. The most extensive bottomlands are found along Skunk River and Indian Creek. In places they are three miles in width.

The drainage of the county is brought about mainly by the Skunk River and its tributaries. The North Skunk River is the second largest stream in the county. It drains the north central and eastern parts of the county, joining the Skunk River in Keokuk County. Elk Creek drains the east central part of the southern half of the county and joins the Skunk River in Mahaska County. The northeast corner of the county is drained by small tributaries of the Iowa River. The southwest corner is drained by small streams that drain into the Des Moines River. The chief tributaries of the Skunk River are Indian Creek, which is the largest and drains the northwestern part of the county, Cherry Creek, Sugar Creek, Prairie Creek and



Carson Creek which enter from the north and east. Squaw and Buck Creeks are the principal tributaries entering the river from the south and west. The Skunk River has been dredged and straightened thruout its course in Jasper County and there has been a large improvement in crop conditions along the river as the result. Overflows are very much less frequent than formerly, and considerable areas of land have been reclaimed and are now suitable for crop production. The chief tributaries of the North Skunk River are Alloway Creek, Rock Creek and Sugar Creek. The chief tributary of Elk Creek is Little Elk Creek.

Drainage conditions in the county as a whole are quite satisfactory except in the northwestern corner where the Wisconsin drift soils occur. The tributaries of the main streams in the county and intermittent drainageways extend into practically all of the upland in the loessial area of the county. The accompanying map indicates quite definitely the extensive natural drainage system of the county and shows that the drainage conditions as a whole are quite adequate. There are areas, however, thruout the county, where drainage is not entirely satisfactory. This condition is particularly noted in the level to depressed upland areas in the northwestern townships but in small areas inadequate drainage is also found in other parts of the county. Wherever this condition occurs the installation of tile is very desirable in order to bring about more satisfactory removal of excess moisture and put the land in the best condition for crop production.

Among the upland soils of the county it may be noted that drainage is apt to be necessary in the Muscatine silt loam, the Grundy silt loam and the Marion silt loam on the loessial upland. On the drift uplands, the Webster

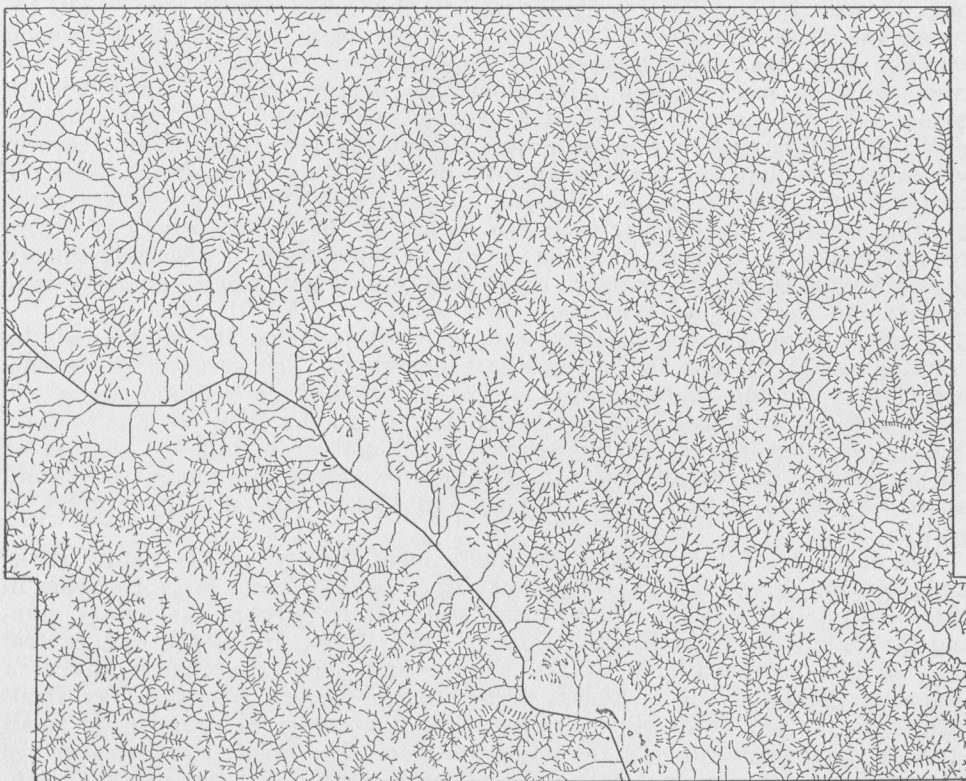


Fig. 3. Map of natural drainage system of Jasper County.

loam, Webster clay loam and Webster silty clay loam are all very apt to be in need of drainage. On the terraces, the Bremer silt loam and Chariton silt loam may need artificial drainage. The bottomlands are sometimes subject to overflow but they are frequently also in need of drainage. Inadequate drainage is evidenced particularly on the Wabash silty clay loam and the Lamoure silty clay loam, but it is also shown in many cases on other types of the Wabash series. The areas of peat and muck represent the location of former ponds and lakes and are an evidence of inadequate drainage. Many areas of bottomland soils have been reclaimed from frequent overflow and would be highly productive if adequate drainage were established.

## THE SOILS OF JASPER COUNTY

The soils of Jasper County are grouped into four classes according to their origin and location. These are: drift soils, loess soils, terrace soils and swamp and bottomland soils. Drift soils are formed from material carried by glaciers and left on the surface of the land upon the retreat of the glaciers. They are variable in composition and contain pebbles and frequently boulders. Loess soils are fine dustlike deposits made by the wind at some time when climatic conditions were very different than at present. Terrace soils are old bottomlands which have been raised above overflow by a decrease in the volume of the streams which deposited them or by depressions in the river channels. Swamp and bottomland soils are those occurring in low, poorly drained areas or along streams, and many of them are subject to more or less frequent overflow. The extent and occurrence of these groups of soils in Jasper County are given in table II.

Over one-fifth of the county is covered by the drift soils, 21.9 percent of the total area being in soils of glacial origin. The major portion of the county is covered by loessial soils. These types are found on 62.5 percent of the county. The terrace soils are minor in extent and cover only 1.9 percent of the county. The bottomland soils are rather extensive, covering 13.7 percent of the county. They occur mainly in narrow areas along the various streams of the county.

There are 32 individual soil types in the county and these with the steep phase of the Carrington loam and the area of peat and muck make a total of 34 soil areas. There are 12 areas of drift soils including the steep phase Carrington loam; 6 areas of loess soils, 9 areas of terrace types and 7 areas of swamp and bottomland soils including the area of peat and muck. The various soil types are distinguished on the basis of certain definite characteristics which are described in the appendix to this report. The names of the types indicate certain group characteristics. The areas covered by the various soil types in the county are given in table III.

The Tama silt loam is the most extensive individual soil type in the county as well as the largest loess soil. It covers 42.3 percent of the total area. The Clinton silt loam is the second largest type in the county and

TABLE II. AREAS OF DIFFERENT GROUPS OF SOILS IN JASPER COUNTY

Soil Groups	Acres	Percent of total area of county
Drift soils .....	101,376	21.9
Loess soils .....	295,345	62.5
Terrace soils .....	7,360	1.9
Swamp and bottomland soils .....	63,119	13.7
Total .....	467,200	....



the second loess soil. It covers 12.8 percent of the county. The Muscatine silt loam is the third loess type in area and sixth type in the county. It covers 5.6 percent of the total area. The Grundy silt loam is minor in area, covering only 0.9 percent of the county. The Knox fine sand and Marion silt loam are also minor in area, covering 0.7 and 0.2 percent of the total area of county, respectively.

The Carrington loam is the third largest type in the county and the most extensive drift soil. Together with the steep phase, which is very much smaller in extent, it covers 10.1 percent of the county. The Shelby loam is the second largest drift soil in the county and the fifth type in area. It covers 7.0 percent of the county. The Lindley loam is the third drift soil in area covering 1.9 percent of the county. The Carrington fine sandy loam is the fourth drift type in area, covering 1.2 percent of the county. The remaining types in the drift soil group are relatively small and unimportant in area. The Carrington fine sand covers 0.7 percent of the county. The Clarion loam covers 0.3 percent, the Clarion fine sandy loam and the Webster loam each cover 0.2 percent of the county. The remaining types cover only 0.1 percent of the county.

The Bremer silt loam, the most extensive terrace type, is small and relatively unimportant in area, covering only 0.4 percent of the county. The Waukesha loam covers the same percentage of the county. The Waukesha silt loam is practically the same in area. The Buckner loam covers 0.2 percent of the county and the remaining terrace types cover only 0.1 percent of the total area.

The Wabash silt loam is the largest bottomland soil in the county and the fourth type in area. It covers 7.6 percent of the county. The Wabash silty clay loam is the second largest bottomland soil and the seventh type in area in the county, covering 5.0 percent of the total area. The Wabash loam is much smaller in area, covering only 0.6 percent of the county. The Wabash clay covers 0.3 percent. The Wabash fine sandy loam covers 0.1 percent of the county and the areas of peat and muck and Lamoure silty clay loam cover less than one percent of the county.

The upland soils of the county vary considerably in topography depending upon the origin and character of the soils. On the glacial uplands the topography ranges from steep to abrupt where the Carrington loam steep phase is mapped and where the Shelby and Lindley soils occur to the more level areas of the Webster soils, the loam, the clay loam and the silty clay loam. On the loessial uplands where the Muscatine silt loam and the Grundy silt loam occur, the topography is rather level. The same is true of the small areas of Marion silt loam. Where the Tama silt loam occurs, however, the topography is gently rolling and the Clinton silt loam is typically rolling to strongly rolling in topography. The terrace and bottomland soils are chiefly level to slightly sloping and the topographic features on the terraces and bottomlands are insignificant.

### THE FERTILITY IN JASPER COUNTY SOILS

Samples were taken for analysis from each soil in the county except the area of peat and muck. This was not sampled because of its variability in character and the fact that many analyses have been made and the composition varies but little.

The more extensive soil types were sampled in duplicate but only one sample was taken from each of the minor types. Samplings were all made with the greatest care that the samples should be representative of the particular soil type and that any variability due to previous treatments might be eliminated. The samples were taken at three depths, 0—6 2/3 inches,

6 2/3—20 inches, and 20 to 40 inches, representing the surface soil, the sub-surface soil and the subsoil, respectively.

The samples were all analyzed for total phosphorus, total nitrogen, total organic carbon, total inorganic carbon, and limestone requirement. The official methods were followed in the determination of the phosphorus, nitrogen and carbon and the Truog qualitative test was used in the determination of the limestone requirement. The figures given in the tables are the averages of the results of duplicate determinations on all samples of each type. They represent, therefore, the averages of 4 or 12 determinations.

TABLE III. AREAS OF DIFFERENT SOIL TYPES IN JASPER COUNTY

Soil No.	Soil type	Acres	Percent of total area of county
DRIFT SOILS			
1	Carrington loam .....	39,040	} 10.1
57	Carrington loam (steep phase) .....	7,872	
79	Shelby loam .....	32,192	
65	Lindley loam .....	9,088	
4	Carrington fine sandy loam .....	5,696	1.2
86	Carrington fine sand .....	3,264	0.7
138	Clarion loam .....	1,408	0.3
149	Clarion fine sandy loam .....	1,152	0.2
55	Webster loam .....	1,024	0.2
32	Lindley silt loam .....	256	0.1
56	Webster clay loam .....	256	0.1
107	Webster silty clay loam .....	128	0.1
LOESS SOILS			
120	Tama silt loam .....	200,817	42.3
80	Clinton silt loam .....	59,840	12.8
30	Muscatine silt loam .....	26,112	5.6
64	Grundy silt loam .....	4,288	0.9
33	Knox fine sand .....	3,136	0.7
67	Marion silt loam .....	1,152	0.2
TERRACE SOILS			
88	Bremer silt loam .....	1,856	0.4
60	Waukesha loam .....	1,856	0.4
75	Waukesha silt loam .....	1,792	0.4
38	Buckner loam .....	896	0.2
45	Buckner fine sandy loam .....	320	0.1
108	O'Neill loam .....	192	0.1
46	Buckner fine sand .....	192	0.1
146	O'Neill fine sand .....	128	0.1
105	Chariton silt loam .....	128	0.1
SWAMP AND BOTTOMLAND SOILS			
26	Wabash silt loam .....	35,328	7.6
48	Wabash silty clay loam .....	23,232	5.0
49	Wabash loam .....	2,816	0.6
72	Wabash clay .....	1,536	0.3
62	Wabash fine sandy loam .....	128	0.1
21	Peat and Muck .....	64	0.05
111	Lamoure silty clay loam .....	15	0.05
	Total .....	467,200	....

## THE SURFACE SOIL

The results of the analysis of the surface soil are given in table IV. They are calculated on the basis of 2 million pounds of surface soil per acre.

The phosphorus content in the various soil types is quite variable, ranging from 444 pounds in the Knox fine sand up to 1,885 pounds per acre in the Lamoure silty clay loam on the bottoms. Definite relationships are not apparent between the phosphorus content of the soils in the different groups and there are wide variations occurring among the types within soil groups. The average of the bottomland soils is slightly higher than the average of the other soil groups, but this might be expected because there has undoubtedly been less crop growth on the bottomland soils and hence a smaller removal of plant food constituents. The relationships among the various soil series and the individual soil types are much more definitely indicated.

Some effects of the characteristics which serve to determine the soil series are evidenced in the results. Thus on the drift uplands it is apparent that the Carrington loam and the other types of the Carrington series are poorer in phosphorus content than the soils of the Webster series. The Clarion soils are somewhat better supplied than the Carrington but they are not as rich as the Webster types. Both the Carrington and the Clarion soils, however, are generally richer than the Shelby or Lindley soils. On the loessial uplands the Muscatine soils are the richest of all the types, in phosphorus. These soils are followed by the Grundy then by the Tama and Clinton and finally by the Marion soils. The Knox types are usually low but in this particular case the soil is a fine sand which makes it abnormally low. On the terraces, the Chariton soil is the highest in phosphorus followed by the O'Neill, the Buckner, the Waukesha and the Bremer. There are variations here which are more dependent upon the texture of the soil, however, than upon the soil series. Ordinarily the Bremer types will run higher in phosphorus than the other terrace soils. In this particular case they are surpassed by the O'Neill and Chariton and to a small extent by some of the Waukesha and Buckner soils. This may be due to some abnormality in the particular sample of the Bremer which was analyzed in this work or because the samples of the other types were somewhat higher than is usual. On the bottoms the Lamoure soils are richer in phosphorus than the Wabash which is quite ordinarily noted.

These variations in phosphorus content probably reflect to a certain extent the characteristics which distinguish the soil series among which may be mentioned, topography, color, and subsoil conditions. Those types which are blacker in color, more level to flat in topography and have heavier subsoils are usually better supplied with phosphorus than the soils which are light in color, rolling in topography, and have light or coarse textured subsoils. There are some variations to this rule but on the drift uplands it is apparent that the Webster soils are richer in phosphorus than the other drift uplands and the Webster types are level to flat in topography, black in color and the subsoils are very heavy. The Lindley and Shelby soils are lighter in color in many cases than the Carrington and Clarion soils. They are inclined to be more steeply rolling in topography and are very apt to have coarser textured subsoils, hence they are lower in phosphorus content. On the loessial uplands the Muscatine silt loam is the darkest in color, more level in topography and has a heavier subsoil and is the richest in phosphorus. The Grundy silt loam comes next in these characteristics and is second in phosphorus content. The Tama and Clinton are very much the same altho in many cases the Tama will run higher in phosphorus than the Clinton soils. The Marion is low as would be expected from the color and other general characteristics of the type.



# SOIL MAP

## JASPER COUNTY, IOWA

IOWA AGRICULTURAL EXPERIMENT STATION  
C. F. Curtiss, Director. W. H. Stevenson, in charge Soil Survey  
P. E. Brown, Associate in charge.

Thomas D. Rice, Insr Northern Division  
Soils surveyed by D. S. Gray, in chand A. M. O'Neal, Iowa Agricultural  
Experiment Station and S.Cole and R. E. Devereux,  
U. S. Dept Agriculture.

U. S. DEPT. OF AGRICULTURE, BUREAU OF SOILS  
Milton Whitney, Chief. Curtiss F. Marbut, in charge of Soil Survey

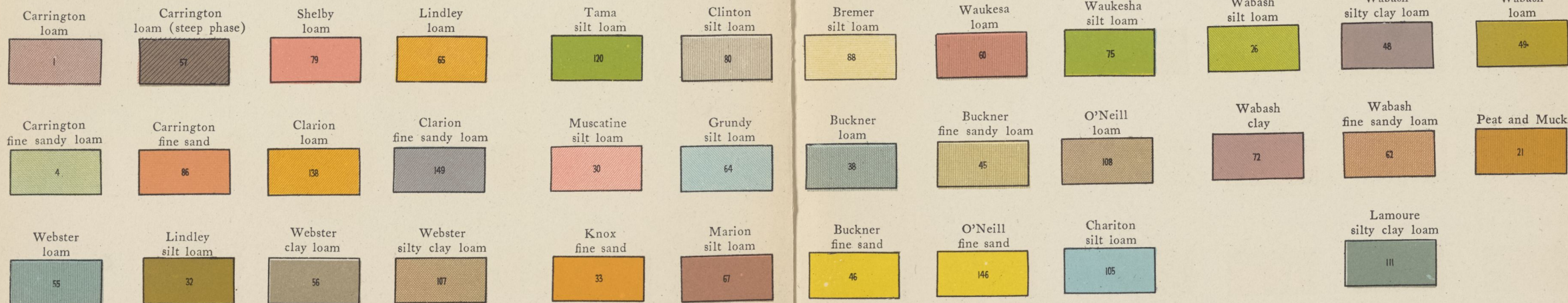
### LEND

#### Drift Soils

#### Loess Soils

#### Terrace Soils

#### Swamp and Bottomland Soils



The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

Scale: 1 Inch 2 1/2 Miles

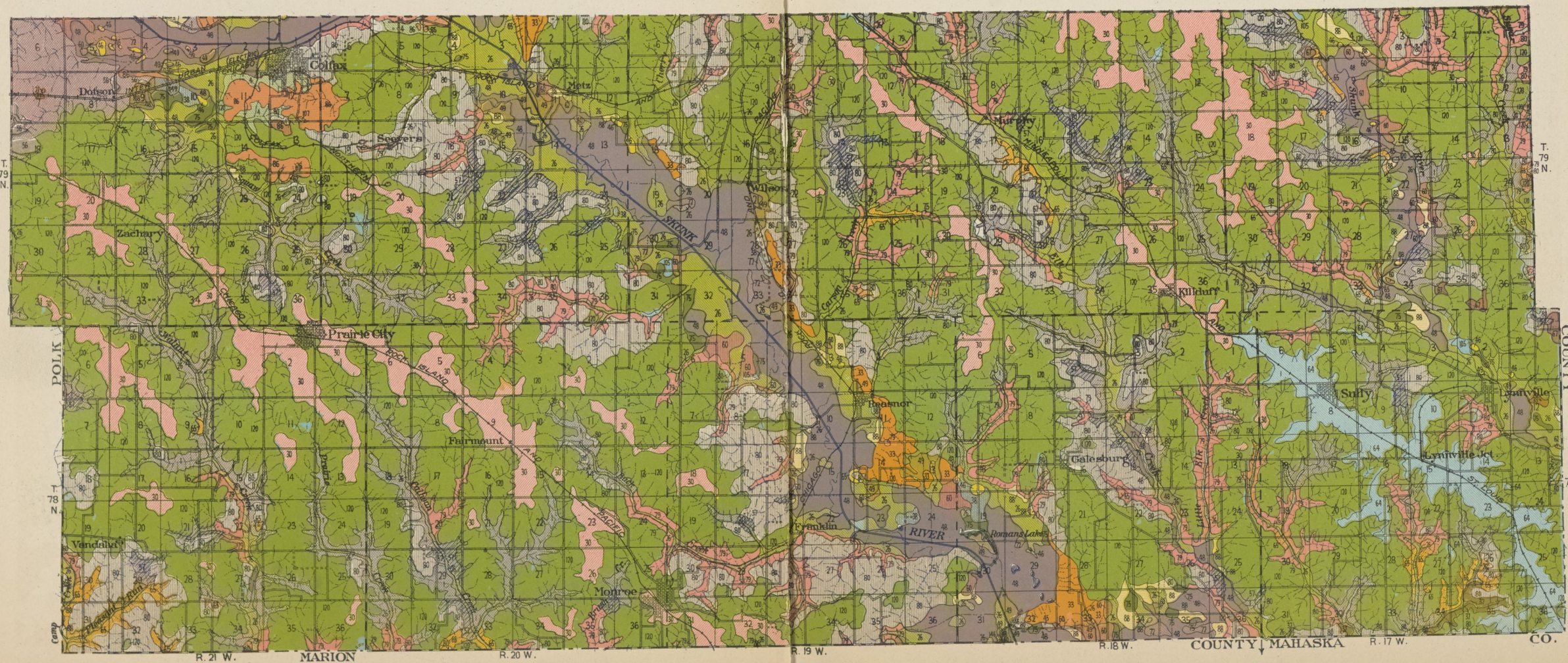




TABLE IV. PLANT FOOD IN JASPER COUNTY, IOWA, SOILS  
Pounds per acre of 2 million pounds of surface soil (0-6½")

Soil No.	Soil type	Total phos-phorus	Total nitro-gen	Total organic carbon	Total in-organic carbon	Lime-stone re-quirement
DRIFT SOILS						
1	Carrington loam .....	821	2,680	37,468	0	8,000
57	Carrington loam (steep phase) .....	619	2,340	32,155	0	6,000
79	Shelby loam .....	794	1,560	22,345	0	8,000
65	Lindley loam .....	700	2,140	28,885	0	8,000
4	Carrington fine sandy loam	767	1,980	21,800	0	8,000
86	Carington fine sand .....	673	660	12,650	0	8,000
138	Clarion loam .....	808	2,940	36,787	0	8,000
149	Clarion fine sandy loam....	1,198	2,540	32,155	0	1,000
55	Webster loam .....	956	5,040	67,852	0	4,000
32	Lindley silt loam .....	902	2,600	30,247	0	8,000
56	Webster clay loam .....	1,414	5,800	77,662	0	2,000
107	Webster silty clay loam...	1,468	5,960	74,510	13,235	0
LOESS SOILS						
120	Tama silt loam .....	1,297	3,853	45,604	0	8,000
80	Clinton silt loam .....	1,306	3,400	38,150	0	6,000
30	Muscatine silt loam .....	1,629	4,120	55,045	0	8,000
64	Grundy silt loam .....	1,320	4,600	59,950	0	8,000
33	Knox fine sand .....	444	120	18,150	0	3,000
67	Marion silt loam .....	983	2,200	29,975	0	4,000
TERRACE SOILS						
88	Bremer silt loam .....	1,252	3,640	55,590	0	4,000
60	Waukesha loam .....	1,104	2,680	38,695	0	8,000
75	Waukesha silt loam .....	1,360	4,100	53,410	0	8,000
38	Buckner loam .....	1,333	3,600	48,232	0	8,000
45	Buckner fine sandy loam ..	1,037	2,260	32,700	0	8,000
108	O'Neill loam .....	1,602	4,720	54,227	0	6,000
46	Buckner fine sand .....	862	1,180	17,672	0	8,000
146	O'Neill fine sand .....	660	480	11,172	0	1,000
105	Chariton silt loam .....	2,033	5,560	69,760	0	8,000
SWAMP AND BOTTOMLAND SOILS						
26	Wabash silt loam .....	1,562	5,020	69,923	0	8,000
48	Wabash silty clay loam ...	1,804	4,380	53,682	0	4,000
49	Wabash loam .....	727	2,320	34,062	0	6,000
72	Wabash clay .....	1,656	3,640	46,597	0	2,000
62	Wabash fine sandy loam ..	1,441	2,760	33,245	0	4,000
111	Lamoure silty clay loam...	1,885	6,820	76,817	3,025	0

On the terraces there is some exception as has already been noted. Thus, the Bremer soils are usually the richest in phosphorus because of their color, topography and subsoil conditions. Occasionally some other factor comes into play, however, and as is the case noted here, one of the O'Neill soils is high in phosphorus. Usually the Waukesha types will run higher than the Buckner and O'Neill soils, but ordinarily there is not very much difference between the surface soil of the Waukesha, the Buckner and the O'Neill soils. Their color is much the same and the only difference is in variations in the subsoil. The Buckner soils tend to be lighter textured in the subsoils and the O'Neill are usually sandy to gravelly, hence they would not be expected to be as well supplied with plant food constituents. On the bottoms the comparison between the Lamoure and the Wabash soils is not very definite altho the Lamoure seems to be richer in phosphorus than the Wabash. This is probably due to the topographic position.



The relationships between the phosphorus content and the texture of the soil is undoubtedly more distinctly shown than is true of other comparisons. Thus the Carrington loam is richer in phosphorus than the fine sandy loam which in turn is better supplied with phosphorus than the fine sand. The Webster silty clay loam is higher in phosphorus than the clay loam and this in turn is very much higher than the Webster loam. The Clarion fine sandy loam is somewhat better supplied than the Clarion loam which is contrary to the usual relationship but there may have been some abnormality in one or the other of these samples. No comparisons of texture are possible among the loessial soils as the types are all silt loams except the Knox fine sand. In the case of this type the content of phosphorus is naturally very low.

On the terraces the Waukesha silt loam is better supplied with phosphorus than the Waukesha loam. The Buckner loam is higher than the Buckner fine sandy loam, which in turn is better supplied than the Buckner fine sand. The O'Neill loam is much higher than the O'Neill fine sand. On the bottoms the Wabash silty clay loam is the richest in phosphorus of any of the Wabash types. This is followed in order by the Wabash clay, the Wabash silt loam, the Wabash fine sandy loam and the Wabash loam. Ordinarily the Wabash loam would be higher in phosphorus than the fine sandy loam.

While there are one or two exceptions it is apparent, however, that in most cases the analyses of these soils bear out previous observation in showing that fine textured types are generally better supplied with phosphorus than are coarse textured soils. Thus silty clay loams are generally richer in phosphorus than silt loams, loams and sandy loams. Silt loams are usually better supplied than sandy types and ordinarily loams are higher in phosphorus than sands or fine sandy soils of the same series.

From the analyses of the soils of this county, it is apparent that the phosphorus supply is inadequate to meet the needs of the crops for any long period. Phosphorus fertilizers will certainly be needed on these soils in the very near future. It looks quite probable, however, that phosphorus fertilizers might be used with profit in many cases at present. The evidence from the greenhouse and field experiments which have been discussed earlier in this report indicate very large effects in many cases from the addition of phosphate fertilizers to some of the more extensive soil types in this county. When the total content is as low as is indicated in many of these soils there is little question but that there will be a deficiency in available phosphorus in the soil and when this is the case the soils will respond to the application of a phosphorus carrier like acid phosphate. In the experiments carried out, rock phosphate and acid phosphate have both been applied, and in many cases both materials have proven profitable. Tests on individual farms of the two materials are therefore very desirable at the present time.

The nitrogen content of the soils of Jasper County is quite as variable as the phosphorus content. The range is from 120 pounds in the Knox fine sand up to 6,820 pounds in the Lamoure silty clay loam. Many of the types seem to be rather poorly supplied with nitrogen; a few are apparently rich in this constituent. The more extensive soil types are fairly well supplied, and the lack of nitrogen or a low content is evidenced chiefly in the coarser textured types which occur on relatively small areas. There is little relation between the nitrogen content of the soils and the various soil groups altho again, as was noted in the case of the phosphorus, the bottomland soils seem to be a little richer in this constituent than the soils of the other groups on the average. The variations are not large, however, and the comparisons undoubtedly simply mean that the bottomland soils have lost less of their nitrogen content from leaching. Such soils also have undoubtedly supported less plant growth and hence there has been a smaller removal from cropping.

Some relationships are evidenced between the nitrogen contents of the soils

and the soil series. Thus on the uplands the Webster types are richer in nitrogen than the other drift soils. The Clarion types are slightly better supplied than the Carrington soils and the latter are richer in nitrogen in general than the Shelby and Lindley soils. On the loessial uplands the Muscatine and Grundy types are the richest in nitrogen, these are followed by the Tama and Clinton soils and the Marion is the lowest. The Knox fine sand is very low in nitrogen chiefly because of its texture. On the terraces the Chariton soil is the richest in nitrogen followed by the O'Neill, the Waukesha, the Bremer and the Buckner types. The comparisons here are confused somewhat by the differences in soil texture and also by the fact that in one or two cases the samples analyzed were probably somewhat abnormal. This is true in the case of the O'Neill loam which shows a very high content of nitrogen, much higher than the Bremer and Waukesha types. Ordinarily the Bremer would be expected to be higher in nitrogen than the Waukesha and O'Neill and the Waukesha would surpass the O'Neill. On the bottoms, the Lamoure soil is better supplied with nitrogen than the Wabash types. Again there is apparent evidence of the effect upon the nitrogen content of the characteristics which to a large extent determine the soil series. The color of the soil, the topographic conditions, and the character of the subsoil are undoubtedly very important.

The relationship of the nitrogen content of the soil to the texture is very definitely shown by some of the analyses. Thus the Carrington loam is richer in nitrogen than the sandy types of the series. The Clarion loam is richer than the Clarion fine sandy loam. The Webster silty clay loam is a little better supplied than the clay loam which is richer than the Webster loam. On the terraces the O'Neill loam is higher than the O'Neill fine sand. The Buckner loam is better supplied than the Buckner fine sandy loam which in turn is richer than the Buckner fine sand. The Waukesha silt loam is better supplied than the Waukesha loam. On the bottoms the Wabash silt loam is a little richer than the Wabash silty clay loam which is contrary to the results which are usually secured with these types. The silty clay loam is richer than the clay, the fine sandy loam is slightly higher than the Wabash loam which again is contrary to the usual results as loams are very apt to be better supplied than fine sandy loams. The differences here, however, are not very large. Taking the results of the analyses as a whole it seems apparent that in general the nitrogen content varies to a large extent with the variations in texture of the soil, fine textured types generally being very much better supplied with nitrogen than coarse textured, sandy soils.

From the analyses of the soils of the county in general it would seem that the nitrogen content must be increased in many cases in order to provide for the best crop growth. While the main soil types are fairly well supplied with this element it must not be overlooked in planning systems of permanent fertility for the county. In many cases, therefore, applications of fertilizing materials supplying nitrogen can be used with profit on the soils of this county at the present time and in all cases some fertilizer carrying nitrogen must be used in order to maintain the fertility of the soils permanently.

The nitrogen content of the soil may be built up and maintained most economically thru the proper use of farm manure, crop residues and leguminous green manure. Farm manure is probably the most important nitrogenous fertilizer which can be employed. It is extremely valuable on the soils of this county because of its ability to return to the soil considerable amounts of the nitrogen removed by the crops grown. The proper use of crop residues will also aid materially in keeping up the content of nitrogen. When the supply of nitrogen in the soil needs to be increased, however, it is very desirable that leguminous crops be turned under as green manures. When legumes are well inoculated they take a large part of their nitrogen from the atmosphere and when they are plowed under for green manuring purposes there is a large addition of nitrogen to the

soil. Leguminous green manuring is an important farm practice as a supplement to farm manuring and also as a substitute for that material on grain farms in order to increase and maintain the supply of nitrogen.

The organic carbon content of the soils of Jasper County varies considerably, ranging from 1,172 pounds in the O'Neill fine sand up to 77,662 pounds in the Webster clay loam. The relationships between the various soil types and their organic carbon content are very much the same as those noted with nitrogen. Thus the Webster types on the glacial uplands are richer in organic matter than the other drift soils. The Clarion types are a little better supplied than the Carrington soils but the differences are not very large. The Shelby and Lindley are the poorest in organic carbon. On the loessial uplands the Muscatine and Grundy soils are the richest in organic matter, followed by the Tama, the Clinton, and Marion and the Knox soils in the order mentioned. Of the terrace types the Chariton silt loam is the richest in organic matter followed by the Bremer, the O'Neill, the Waukesha and the Buckner soils. On the bottoms the Lamoure silty clay loam is the richest in organic carbon, being much better supplied than any of the Wabash types.

Again it would seem that the soil characteristics which serve as a basis for the separation of series are closely related to the organic carbon or organic matter content. Those types which are black in color, level in topography, poorly drained and with heavy subsoils, are generally much higher in organic carbon as well as in nitrogen.

The relationships between organic matter and texture are likewise much the same as those noted in the case of nitrogen. Thus the heavier textured Webster soils are higher in this element than the lighter textured types. The clay loam is a little richer than the silty clay loam but the difference is not very large. The Carrington loam is higher in organic matter than the fine sandy loam which in turn is richer than the fine sand. The Clarion loam is richer in organic matter than the fine sandy loam. On the terraces the Waukesha silt loam is richer than the Waukesha loam. The Buckner loam is better supplied than the fine sandy loam, which in turn is higher in organic matter than the fine sand of the same series. The O'Neill loam is very much higher in organic matter than the O'Neill fine sand. On the bottomlands the Wabash silt loam is higher than the silty clay loam which again is the opposite of the results usually secured. The silty clay loam is richer than the clay which in turn is better supplied than the Wabash loam or the fine sandy loam, the latter being low in organic matter content. Again it appears that in general fine textured soils are very much better supplied with organic matter and nitrogen than are coarse textured soils.

The relationship between the carbon content and the nitrogen in the soils indicates the rapidity with which plant food constituents are changed into an available form. In many of the soils in Jasper County the relationships are such that there is apparently inadequate decomposition proceeding in these soils and hence undoubtedly they are low in the production of available constituents. On these types the application of farm manure is of particularly large value, inasmuch as it stimulates the production of available plant food. This condition is evidenced particularly in the Marion silt loam and Clinton silt loam, the Carrington fine sandy loam and some of the other sandy types on the uplands. It is also evidenced in a number of the sandier types on the terraces and bottoms. Some of the heavier soils in these latter positions are also apparently low in the production of available plant food.

The need of fertilizing materials to supply organic matter to soils of this county is evidenced by the analysis of many of the types. On the coarse textured sandy soils there is need at the present time for organic matter, and many of the types will respond in a very large way to applications of materials supplying organic matter. The use of farm manure brings about very large increases in crop yields on these coarse textured soils. Likewise, however, large effects are evidenced from the use of farm manure on some of the heavier textured types. It



is very important in building up the crop producing power of these soils and in maintaining them at a high state of productivity, that there be a liberal application of farm manure to practically all of the soils in the county. Crop residues should also always be utilized as they aid materially in maintaining the supply of organic matter. The use of leguminous crops as green manures is often very desirable as a supplement to the farm manure. They should be used very largely on the grain farms where little or no farm manure is available.

Only two of the soil types in the county show any content of inorganic carbon in the surface soil and these are the only types which are not acid in reaction. The Webster silty clay loam on the uplands and the Lamoure silty clay loam on the bottomlands contain considerable amounts of lime in the surface soil and thruout the soil section. In all of the other types in the county the surface soils are acid in reaction and show a very definite need for lime. In several cases there is some lime in the lower part of the three foot sections in some of the types. This is the case in the Clarion loam, the Clarion fine sandy loam, the Webster loam and the Webster clay loam, but even on these types there is apt to be a need for lime in the surface soil. The presence of lime in the subsoil is not sufficient to take care of the needs of the early growth of leguminous crops.

The amount of lime required by the different soil types of the county is extremely variable. The figures given in the table can be considered, however, merely to indicate very rough comparisons. They do not show definitely the needs of all the soils of the same type in the county. The lime requirements of soils vary widely even within the same type and tests of every individual soil from any particular field are necessary if the limestone requirement is to be determined accurately.

Evidently all the soils of Jasper County with the exception of the Webster silty clay loam and the Lamoure silty clay loam should be tested for lime requirement or acidity and if the soils are to be most satisfactorily productive, lime must be provided as required by these tests. Increases in crop yields are always secured from the use of lime on acid soils. If legumes are to be grown it is particularly necessary to apply lime, and in some cases it may mean the difference between a very satisfactory crop yield and no crop at all.

#### THE SUBSURFACE SOILS AND SUBSOILS

The results of the analyses of the subsurface soils and subsoils are given in tables V and VI. They are calculated on the basis of 4 million pounds of subsurface soil and 6 million pounds of subsoil per acre.

Generally the analyses of the surface soil indicate quite accurately the plant food content and crop producing power of the soil. There is not apt to be any large effect upon the fertility of the soil from the plant food present in the lower soil layers, unless there is a very large amount of some constituent present or a very striking deficiency. The lower soil layers in Jasper County are not particularly high in any plant food nor are they noticeably lacking, hence it will be unnecessary to consider these results in detail.

Attention may merely be called to the fact that the analyses of these lower soil layers serve to confirm the conclusions reached in the discussion of the surface soils. Applications of phosphorus fertilizers will certainly be needed in the very near future and indeed, it appears that they might often prove profitable for use at the present time.

The content of organic matter and nitrogen is low in some of the soils but is apparently quite adequate in many of the types. In some cases, therefore, there is need for an increase in the supply of nitrogen and organic matter in the soils and in all cases care should be taken that the amount of these constituents be maintained. The increase and maintenance of organic matter and nitrogen in the soils may be accomplished thru the proper use of farm manures, crop residues and leguminous green manures.

## SOIL SURVEY OF IOWA

In several cases there is a supply of lime in the lower soil layers where the surface soil is acid. This is true in the case of the Clarion types and the Webster loam and Webster clay loam. This, however, does not change the fact that lime may be needed on the surface soils of these types for the best growth of legumes. Evidence has been presented showing the value of applications of lime to some of these soils when the surface soil is acid in reaction. All the soils of the county, therefore, except the Webster silty clay loam and the Lamoure silty clay loam which show a high content of lime thruout the soil section, should be tested for acidity and the amount of lime the test shows to be necessary should be applied, if the best growth of crops is to be secured. Emphasis should also be placed on the fact that on many of the types it is important that the soils be tested regularly in order that the supply of lime may be kept up.

TABLE V. PLANT FOOD IN JASPER COUNTY, IOWA, SOILS  
Pounds Per Acre of 4 Million Pounds of Subsurface Soil (6 $\frac{2}{3}$ "-20")

Soil No.	Soil type	Total phosphorus	Total nitrogen	Total organic carbon	Total inorganic carbon	Limestone requirement
DRIFT SOILS						
1	Carrington loam .....	1,198	3,200	42,237	.....	8,000
57	Carrington loam (steep phase) .....	1,158	2,400	32,155	.....	8,000
79	Shelby loam .....	1,131	1,880	21,800	.....	8,000
65	Lindley loam .....	996	1,000	14,715	.....	8,000
4	Carrington fine sandy loam.	1,480	2,120	31,610	.....	8,000
86	Carrington fine sand .....	1,212	960	14,715	.....	6,000
138	Clarion loam .....	1,347	2,800	33,790	.....	4,000
149	Clarion fine sandy loam....	1,884	4,200	43,055	.....	1,000
55	Webster loam .....	1,293	4,400	67,580	.....	2,000
32	Lindley silt loam.....	1,534	2,160	22,345	.....	8,000
56	Webster clay loam.....	2,046	3,320	52,865	.....	1,000
107	Webster silty clay loam...	4,524	19,400	225,765	107,775	.....
LOESS SOILS						
120	Tama silt loam.....	1,768	4,840	55,771	.....	8,000
80	Clinton silt loam.....	2,128	2,080	22,890	.....	8,000
30	Muscatine silt loam.....	2,288	5,000	67,580	.....	8,000
64	Grundy silt loam .....	2,182	6,800	87,200	.....	8,000
33	Knox fine sand.....	834	640	9,810	.....	6,000
67	Marion silt loam.....	1,966	2,000	22,890	.....	8,000
TERRACE SOILS						
88	Bremer silt loam.....	1,724	3,480	67,035	.....	3,000
60	Waukesha loam .....	2,074	4,600	64,855	.....	8,000
75	Waukesha silt loam.....	2,262	5,920	73,575	.....	8,000
38	Buckner loam .....	2,236	4,760	64,855	.....	8,000
45	Buckner fine sandy loam..	1,454	2,880	35,425	.....	8,000
108	O'Neill loam .....	2,316	1,900	48,505	.....	4,000
46	Buckner fine sand.....	1,616	1,480	20,710	.....	6,000
146	O'Neill fine sand.....	1,135	360	10,678	.....	5,000
105	Chariton silt loam.....	2,208	4,280	62,675	.....	8,000
SWAMP AND BOTTOMLAND SOILS						
26	Wabash silt loam.....	2,154	4,720	73,248	.....	4,000
48	Wabash silty clay loam....	2,262	4,240	53,410	.....	3,000
49	Wabash loam .....	1,346	2,360	43,600	.....	2,000
72	Wabash clay .....	3,690	5,000	76,300	.....	2,000
62	Wabash fine sandy loam...	2,046	4,360	55,590	.....	4,000
111	Lamoure silty clay loam...	3,690	5,400	101,915	5,672	.....

TABLE VI. PLANT FOOD IN JASPER COUNTY, IOWA, SOILS  
Pounds Per Acre of 6 Million Pounds of Subsoil (20"-40")

Soil No.	Soil type	Total phosphorus	Total nitrogen	Total organic carbon	Total inorganic carbon	Limestone requirement
DRIFT SOILS						
1	Carrington loam .....	1,817	3,000	40,052	.....	8,000
57	Carrington loam (steep phase) .....	1,414	840	13,080	.....	8,000
79	Shelby loam .....	1,293	2,160	26,160	.....	8,000
65	Lindley loam .....	1,414	840	22,072	.....	8,000
4	Carrington fine sandy loam .....	2,220	2,400	28,612	.....	8,000
86	Carrington fine sand.....	1,212	1,200	11,445	.....	2,000
138	Clarion loam .....	2,706	2,040	26,277	59,560	.....
149	Clarion fine sandy loam...	2,826	1,560	29,014	73,173	.....
55	Webster loam .....	2,586	2,160	33,011	11,134	.....
32	Lindley silt loam.....	1,333	1,440	22,890	.....	8,000
56	Webster clay loam.....	3,273	1,440	27,829	13,046	.....
107	Webster silty clay loam...	5,616	10,440	152,385	130,465	.....
LOESS SOILS						
120	Tama silt loam.....	2,289	3,920	44,690	.....	8,000
80	Clinton silt loam.....	3,636	2,760	29,430	.....	6,000
30	Muscatine silt loam.....	3,111	3,840	47,415	.....	8,000
64	Grundy silt loam.....	2,544	5,660	76,845	.....	8,000
33	Knox fine sand.....	808	400	11,445	.....	2,000
67	Marion silt loam.....	3,354	1,920	24,525	.....	8,000
TERRACE SOILS						
88	Bremer silt loam.....	2,586	2,760	62,130	.....	3,000
60	Waukesha loam .....	3,069	3,480	52,320	.....	8,000
75	Waukesha silt loam.....	2,667	4,560	94,830	.....	8,000
38	Buckner loam .....	2,826	4,920	58,860	.....	8,000
45	Buckner fine sandy loam...	3,354	2,320	43,380	.....	8,000
108	O'Neill loam .....	2,463	1,680	30,247	.....	4,000
46	Buckner fine sand.....	1,776	1,200	25,342	.....	6,000
146	O'Neill fine sand.....	1,899	840	21,258	.....	1,400
105	Chariton silt loam.....	3,756	3,720	52,320	.....	6,000
SWAMP AND BOTTOMLAND SOILS						
26	Wabash silt loam.....	2,907	2,760	64,582	.....	3,000
48	Wabash silty clay loam...	2,544	2,520	44,145	.....	2,000
49	Wabash loam .....	2,019	1,200	31,065	.....	2,000
72	Wabash clay .....	8,040	4,680	81,750	.....	2,000
62	Wabash fine sandy loam...	2,100	4,080	55,590	.....	4,000
111	Lamoure silty clay loam...	6,060	4,920	106,902	10,036	.....

### GREENHOUSE EXPERIMENTS

Two greenhouse experiments were carried out on soils from Jasper County to determine their fertilizer needs and to learn the value of the application of certain fertilizing materials. These tests were carried out on the Tama silt loam and the Carrington loam, two of the most extensive soil types in the county. Experiments are also included on the Tama silt loam from Marshall County, on the Carrington loam from Marshall County, on the Carrington loam from Polk County, and on the Clinton silt loam from Wapello County. As these soils are the same as those occurring in Jasper County, the results secured indicate quite definitely the effects of the same fertilizer treatment on the particular soils in Jasper County.

The fertilizers tested were the same in all the experiments and they included



the application of manure, lime, rock phosphate, acid phosphate and a complete commercial fertilizer. These materials were added in the amounts in which they are applied in the field, hence the results may be considered to indicate the fertilizer effects which may be secured on the farm. Manure was added at the rate of 8 tons per acre, lime was applied in sufficient amounts to neutralize the acidity of the soil and supply two tons additional, rock phosphate was added at the rate of 2,000 pounds per acre, acid phosphate at the rate of 200 pounds per acre, and a standard 2-8-2 complete commercial fertilizer at the rate of 300 pounds per acre. Wheat and clover were grown, the clover being seeded about one month after the wheat was up.

#### RESULTS ON THE TAMA SILT LOAM

The results of the experiment on the Tama silt loam from Jasper County are given in table VII, the figures being the averages of the weights of the wheat and clover on the duplicate pots. The application of manure brought about a distinct increase in the yield of both the wheat and the clover, the latter crop being almost doubled by the manure. Lime with manure had an additional effect on both crops, showing up a gain on the wheat as well as on the clover. The rock phosphate showed a small effect on the wheat and similarly a slight effect on the clover. Acid phosphate brought about a larger effect on the wheat than did the rock phosphate and it had a very much larger influence on the yield of clover. The complete commercial fertilizer gave about the same increase in wheat as that occasioned by the acid phosphate but it had less effect on the clover, showing up about the same as the rock phosphate in the case of the latter crop.

It appears from these results that this soil will respond in a very large way to applications of manure, lime, and a phosphate fertilizer. The value of applications of manure is very definitely shown by the data. Large increases in crop yields are secured by the application of this material. The application of lime is very desirable on the type, as it is usually acid and without lime the yields of general farm crops and particularly of legumes, will not be entirely satisfactory. Acid phosphate seemed to give a somewhat larger effect on the crops in this test than rock phosphate, but definite conclusions should not be drawn from one experiment. It is apparent, however, that one or the other of these phosphate fertilizers should be employed on this soil and that profitable results may be secured from the application. The complete commercial fertilizer



Fig. 4. Clover on Tama silt loam, Jasper County.

TABLE VII. GREENHOUSE EXPERIMENT—TAMA SILT LOAM—  
JASPER COUNTY

Pot No.	Treatment	Weight of wheat grain in grams	Weight of clover in grams
1	Check .....	7.6	11.0
2	Manure .....	9.4	21.8
3	Manure+lime .....	10.9	22.7
4	Manure+lime+rock phosphate .....	11.2	23.2
5	Manure+lime+acid phosphate .....	11.5	26.1
6	Manure+lime+complete commercial fertilizer..	11.6	23.3

had less effect than the acid phosphate on the clover crop and only a very slightly larger effect on the wheat, hence it would not seem that a complete fertilizer would be as profitable for use as acid phosphate on this soil.

## RESULTS ON THE CARRINGTON LOAM

The results obtained on the Carrington loam from Jasper County are given in table VIII. The very large beneficial effects of manure on this type is very clearly shown by the data. The wheat yield was increased considerably and the clover yield was almost doubled by the manure. The application of lime with the manure gave a distinct increase in the yield of wheat and showed a gain in the clover crop. Rock phosphate and acid phosphate showed very similar increases on both crops, the acid phosphate being somewhat larger in effect in both cases. The differences, however, were not sufficiently great to be of large significance. The complete commercial fertilizer had a larger effect on the wheat than did the phosphorus carriers, but it showed less effect on the clover.

The Carrington loam will apparently respond in a very large way to applications of farm manure, lime and a phosphorus fertilizer. The beneficial effects of farm manure are very definitely shown by the data. The addition of lime proves of value on this type, not only in increasing the yields of leguminous crops but also by bringing about greater crop yields of other general farm crops.



Fig. 5. Wheat and clover on Tama silt loam, Jasper County.





Fig. 6. Wheat and clover on Carrington loam, Jasper County.

The application of a phosphate fertilizer would certainly be of large value on this soil. Whether acid phosphate or rock phosphate should be employed cannot be definitely stated from the data. It would seem that acid phosphate is slightly superior but the variations in yields secured in this experiment were not great. While the complete commercial fertilizer showed up somewhat better than the acid phosphate on the wheat crop, it had less effect on the clover. It would not seem, therefore, that a complete commercial fertilizer would be as profitable for use in general as the application of acid phosphate.

#### RESULTS ON THE TAMA SILT LOAM FROM MARSHALL COUNTY

The results secured on the Tama silt loam from Marshall County are given in table IX. Manure had a very large effect on the wheat crop in this experiment but showed no effect on the clover. Lime in addition to manure increased the wheat yields slightly but brought about a distinct increase in the clover. It would be expected ordinarily that the application of lime would show a much larger effect on the legume crop of the rotation. Rock phosphate had little effect on the wheat but brought about a distinct increase in the clover crop. Acid phosphate showed a very pronounced gain in the yield of wheat, and a very large gain in the case of the clover. The complete commercial fertilizer showed less effect than the acid phosphate in the case of both crops but it had a slightly larger effect than the rock phosphate on the clover.

These data confirm the conclusions drawn from the tests of the Tama silt loam from Jasper County and indicate the very large value of applications of manure, lime and phosphorus to this type. The beneficial effects of manure are very definitely shown, lime is needed on the soil as it is acid in reaction and the effects of lime will be particularly evidenced on the legume crop of the rotation. The application of a phosphate fertilizer is very desirable. It would seem that acid phosphate may be preferable for use but definite conclusions cannot be drawn from the data. Apparently a complete commercial fertilizer would be less profitable for use on this soil than acid phosphate.



Fig. 7. Clover on Carrington loam, Jasper County.

#### RESULTS ON THE CARRINGTON LOAM FROM MARSHALL COUNTY

The results obtained in the greenhouse experiment on the Carrington loam from Marshall County are given in table X. The beneficial effects of manure are shown very definitely by the increased yields of wheat and of clover in this experiment. There was a large gain in the wheat crop and the yield of clover was doubled. Lime with manure increased the wheat yields slightly but had no effect on the clover. Ordinarily lime brings about a large increase in the legume crop, on this type. Rock phosphate, acid phosphate, and the complete commercial fertilizer all gave distinct increases in yields of both wheat and clover. There was very little difference in the effect of the three materials on the wheat crop but the acid phosphate showed up very much better in the case of the clover. The results, however, would not permit of a definite choice being made between these two fertilizing materials, rock phosphate and acid phosphate. It would not seem that the complete commercial fertilizer could be considered as profitable for use inasmuch as it gives less effect than the acid phosphate.

The results secured on the Carrington loam from Jasper County are thus confirmed by the data secured on the same type from another county. It is apparent that manure is an extremely valuable fertilizing material for this soil. When the type is acid, applications of lime are necessary and increases in crop yields are quite generally secured from the use of lime. Phosphorus fertilizers will undoubtedly prove of value on the soil and tests of acid phosphate and rock phosphate are recommended.

TABLE VIII. GREENHOUSE EXPERIMENT—CARRINGTON LOAM.  
JASPER COUNTY

Pot No.	Treatment	Weight of wheat grain in grams	Weight of clover in grams
1	Check .....	8.3	10.7
2	Manure .....	10.2	19.9
3	Manure+lime .....	11.8	22.4
4	Manure+lime+rock phosphate .....	12.2	24.3
5	Manure+lime+acid phosphate .....	12.9	25.6
6	Manure+lime+complete commercial fertilizer..	14.5	21.9



TABLE IX. GREENHOUSE EXPERIMENT, TAMA SILT LOAM,  
MARSHALL COUNTY

Pot No.	Treatment	Weight of wheat grain in grams	Weight of clover in grams
1	Check .....	19.75	45.36
2	Manure .....	23.00	45.36
3	Manure+lime .....	23.50	49.89
4	Manure+lime+rock phosphate .....	24.00	54.43
5	Manure+lime+acid phosphate .....	27.50	72.63
6	Manure+lime+complete commercial fertilizer	24.00	63.50

## RESULTS ON THE CARRINGTON LOAM FROM POLK COUNTY

The results secured on the Carrington loam from Polk County are given in table XI. Again it is apparent that manure is of large value on this type. Very definite increases were secured in the yields of both the wheat and clover in this experiment. The application of lime with manure showed no effect on the wheat but brought about a pronounced increase in the yield of clover. The application of rock phosphate with manure and lime increased the yields of both crops considerably, the effect being particularly noticeable on the clover. Acid phosphate showed slightly larger effects than rock phosphate in the case of wheat and had a very much larger effect on the clover. The complete commercial fertilizer showed a larger effect on the wheat than did the acid phosphate but had the same effect as the acid phosphate on the clover.

The Carrington loam will certainly respond in a very large way to applications of farm manure, lime and a phosphate fertilizer, as indicated again by this data on the type from an adjacent county. The large effect of manure on the yield of wheat and clover is shown very definitely. The beneficial effect of lime in remedying the acidity of the soil is very clearly shown by the increased yield of clover. The value of a phosphate fertilizer is indicated by very appreciable increases in the yields of both crops. Acid phosphate seems to be somewhat greater in effect than rock phosphate but the differences are not large enough so that definite conclusions can be drawn. Tests on the farm of the two mate-



Fig. 8. Greenhouse experiment with clover on Tama silt loam from Marshall County.

TABLE X. GREENHOUSE EXPERIMENT, CARRINGTON LOAM,  
MARSHALL COUNTY

Pot No.	Treatment	Weight of wheat grain in grams	Weight of clover in grams
1	Check .....	16.5	22.68
2	Manure .....	24.0	45.36
3	Manure+lime .....	25.0	40.82
4	Manure+lime+rock phosphate .....	27.0	49.89
5	Manure+lime+acid phosphate .....	27.5	54.43
6	Manure+lime+complete commercial fertilizer..	26.0	49.89

rials are very desirable. The complete commercial fertilizer cannot be recommended for general use over acid phosphate inasmuch as the increases secured from its application are not sufficiently greater to warrant the greater cost of the material.

## RESULTS ON THE CLINTON SILT LOAM FROM WAPELLO COUNTY

The results secured on the Clinton silt loam from Wapello County are shown in table XII. The application of manure to this type brought about increased yields of wheat and caused a very large increase in the clover yield. When lime was applied with manure the yields of both crops were increased considerably, the effect being the greater in the case of the clover. Rock phosphate increased the yield of wheat very definitely and showed a very large effect on the clover. Acid phosphate and the complete commercial fertilizer brought about increases in both crops, showing less influence on the clover than that brought about by the rock phosphate but having about the same effect as the rock phosphate on the wheat.

From these results it is apparent that manure is a very valuable fertilizer for use on the Clinton silt loam, and liberal applications of it should be made. Lime



Fig. 9. Wheat and clover on Carrington loam, Marshall County.



TABLE XI. GREENHOUSE EXPERIMENT, CARRINGTON LOAM, POLK COUNTY

Pot No.	Treatment	Weight wheat grain in grams	Weight clover in grams
1	Check .....	5.50	27.21
2	Manure .....	11.50	40.82
3	Manure+lime .....	11.50	48.89
4	Manure+lime+rock phosphate .....	13.00	52.16
5	Manure+lime+acid phosphate .....	13.50	56.69
6	Manure+lime+complete commercial fertilizer	15.50	56.69

in addition to manure is very necessary when the type is acid in reaction and it will increase crop yields greatly, particularly in the case of legumes. Phosphorus fertilizers would undoubtedly prove profitable for use on this type. Definite conclusions regarding the relative value of rock phosphate and acid phosphate cannot be drawn from the experiment given here and tests on individual farms are recommended. It would not seem that a complete commercial fertilizer is as desirable for use on this soil as acid phosphate, inasmuch as it does not seem to bring about any larger crop increases.

### FIELD EXPERIMENTS

A field experiment has been started in Jasper County but results have not been secured over a long enough period for the data to be of value at the present time. Field experiments are under way in other counties, however, on soil types which occur extensively in Jasper County. The results secured on some of these fields will be presented here, inasmuch as they show quite clearly the results which may be secured on the same soils in this county. Experiments are included on the Tama silt loam on the Hudson field in Black Hawk County, on the Carrington loam on the Jesup field in Black Hawk County, on the Carrington loam on the Eldora field in Hardin County, on the Clinton silt loam on the Princeton field in Scott County, and on the Muscatine silt loam on the Blue Grass field in Scott County. Average results are also given for the Tama silt loam and the Carrington loam secured on all the fields on those soil types in the state.

These field experiments are planned to determine the value of various soil treatments and they are laid out on land which is representative of the particular soil type. The fields include 13 plots, each 155 feet 7 inches by 28 feet, or one-tenth of an acre in size. They are permanently located by the installation of corner stakes and all precautions are taken in applying fertilizers and harvesting the crops to secure accurate results.

The fields include tests under the livestock system of farming and under the grain system. In the former, manure is applied while in the latter, crop residues are employed. The other fertilizing materials tested include limestone, rock phosphate, acid phosphate and a complete commercial fertilizer. Manure is applied at the rate of 8 tons per acre once in a four year rotation. The crop residues treatment consists in plowing under the cornstalks which have

TABLE XII. GREENHOUSE EXPERIMENT, CLINTON SILT LOAM, WAPELLO COUNTY

Pot No.	Treatment	Weight wheat grain in grams	Weight clover in grams
1	Check .....	21.0	31.7
2	Manure .....	22.0	47.6
3	Manure+lime .....	26.5	54.3
4	Manure+lime+rock phosphate .....	30.7	67.9
5	Manure+lime+acid phosphate .....	30.5	58.8
6	Manure+lime+complete commercial fertilizer	30.7	58.9

been cut with a disc or stalk cutter, turning under the straw from the small grains and the plowing under of at least the second crop of clover. Sometimes the first crop of clover is cut and allowed to remain on the land to be plowed under with the second. Lime is applied in sufficient amounts to neutralize the acidity of the soils and supply two tons in addition. Rock phosphate is added at the rate of 2,000 pounds per acre once in a four year rotation. Acid phosphate is employed at the rate of 200 pounds per acre annually. Until 1923 the old standard 2-8-2 complete commercial fertilizer was employed, being applied at the rate of 300 pounds per acre annually. Now the new standard 2-12-2 is being used, application being made at the rate of 267 pounds per acre annually, thus supplying the same amount of phosphorus as that contained in 200 pounds of acid phosphate.

#### THE HUDSON FIELD

The results secured on the Tama silt loam on the Hudson field in Black Hawk County are given in table XIII. The beneficial effect of manure on this soil type is evidenced very definitely by the results of this experiment. Increases in crop yields were secured each season from the application of manure. The largest increase was evidenced on the oats in 1924. Considerable increases were also secured, however, on the corn in 1920 and on the oats in 1922. The application of lime with the manure brought about further increases in the yields of all the crops grown. Apparently lime will prove beneficial on this type for the growth of all general farm crops. It would undoubtedly have larger effect on the legume crops.

The addition of rock phosphate or acid phosphate with the manure and lime increased the crop yield each year of the experiment except in 1922, when no increases were secured on the oats, and in 1923 when the corn crop showed no increase. In 1919, the oats showed a large increase from both phosphates and again, in 1920, large increases were secured. The greatest effect of both the rock phosphate and the acid phosphate appeared, however, on the oats in 1924. An increase of over 11 bushels was secured from each material. The effects of the two phosphates permit of no definite conclusions regarding their relative value, as the results are about the same for both. The differences are too slight to be of significance. The complete commercial fertilizer showed slightly larger effects than the acid phosphate in some seasons but in other years had a slightly smaller influence. Apparently this material would not be of any superior value over acid phosphate.

The crop residues treatment had little effect on the yields of the various crops grown. Slight increases were secured in one or two seasons. The addition of lime with the crop residues brought about increases in crop yields each year. In some seasons very large increases in crops were secured. For instance, in 1922, there was a very large increase in the oats. Again in 1923, the corn showed a large increase from the lime addition. Considerable effect was also evidenced on the oats in 1924.

The rock phosphate or acid phosphate applied with crop residues and lime increased the yields of several of the crops. The corn in 1920 was increased by both materials, and the corn in 1918 showed an increase from the use of the rock phosphate. The oats in 1922 were increased by the acid phosphate and both materials increased the oats crop in 1924, the rock phosphate showing up somewhat better than the acid phosphate. While the rock phosphate seems to give quite as large effects as the acid phosphate in several cases, definite conclusions can not be drawn from this data as the differences in the relative effects of the two phosphates are not sufficiently definite. The complete commercial fertilizer showed larger effects than the acid phosphate only in the case of the oats in 1922. It was a little better than acid phosphate in 1924 but did not show up as



TABLE XIII. FIELD EXPERIMENT—TAMA SILT LOAM—BLACK HAWK COUNTY.  
HUDSON FIELD—SERIES II

Plot No.	Treatment	1918 <sup>1</sup> corn bu. per A.	1919 oats bu. per A.	1920 <sup>2</sup> corn bu. per A.	1921 <sup>3</sup> corn bu. per A.	1922 <sup>4</sup> oats bu. per A.	1923 <sup>5</sup> corn bu. per A.	1924 oats bu. per A.
1	Check .....	45.8	47.6	53.2	...	44.8	54.0	40.3
2	Manure .....	49.3	54.7	62.8	...	53.1	59.6	50.6
3	Manure+lime .....	54.4	59.2	67.4	...	59.6	65.2	52.2
4	Manure+lime+rock phosphate .....	56.5	64.9	73.3	...	58.1	61.4	63.4
5	Manure+lime+acid phosphate .....	57.4	62.2	73.3	...	53.2	59.6	63.7
6	Manure+lime+com- plete commercial fertilizer .....	58.5	57.5	72.4	...	62.2	68.4	60.0
7	Check .....	56.9	62.2	44.0	...	41.4	54.8	50.6
8	Crop residues .....	54.7	62.2	65.2	...	49.0	53.1	49.5
9	Crop residues+lime ..	57.9	64.6	71.3	...	62.4	66.7	57.7
10	Crop residues+lime+ rock phosphate ....	62.8	58.1	74.9	....	59.6	65.7	66.4
11	Crop residues+lime+ acid phosphate ....	55.6	55.8	74.9	...	64.4	62.8	60.9
12	Crop residues+lime+ complete commer- cial fertilizer ....	52.5	57.5	74.1	...	71.3	62.8	61.5
13	Check .....	54.5	57.0	71.3	...	59.7	50.2	48.7

<sup>1</sup>Four tons lime. Hail damaged corn.<sup>2</sup>Yield on plot 7 evidently an error.<sup>3</sup>Corn cut and put in silo.<sup>4</sup>Not very ripe when cut.<sup>5</sup>Dry season.

well as the rock phosphate in that year. The same was true of the oats in 1919. It would not seem, therefore, that the complete commercial fertilizer would be as profitable for use on this soil as acid phosphate.

The results of this experiment indicate quite definitely the beneficial effects of applications of manure, lime and a phosphate fertilizer to the Tama silt loam. Large increases in crop yields are secured from the liberal application of manure to this type. The soil is acid in reaction and the application of lime is very desirable. Not only will the yields of leguminous crops be increased by the proper use of lime but, as evidenced in this experiment, considerable increases in yields of general farm crops such as corn and oats may be secured.

The application of a phosphate fertilizer is certainly very desirable on this soil. Whether rock phosphate or acid phosphate should be employed cannot be definitely stated from the data given here. Under the grain system of farming the rock phosphate showed up a little better than the acid phosphate in one or two cases. Under the livestock system of farming the acid phosphate showed up somewhat better than the rock phosphate but in other cases the rock phosphate proved a little superior. The differences between the effects of the two materials were not sufficient, however, so that a choice could be made. Tests on the individual farms of rock phosphate and acid phosphate are recommended. While the complete commercial fertilizer gave somewhat larger returns in the way of crop increases in some crops over acid phosphate, the gains were not large enough so that the use of a complete commercial fertilizer could be considered as desirable on this soil as the application of a phosphorus carrier.

#### THE JESUP FIELD

Results secured on the Carrington loam on the Jesup field in Black Hawk County are given in table XIV. The value of applications of manure to this

soil is evidenced by the results secured. Increases in crop yields were secured in practically all cases from the addition of manure. In some seasons the increases were very large. Corn, in 1921, showed an increase of 14 bushels from the application of the manure. In 1922, there was a similar increase in the yield of corn. Appreciable gains were secured also in the clover and in the timothy and clover yields. The addition of lime with the manure brought about further increases in crop yields in practically all cases. Increases were noted particularly on the timothy and clover in 1920 and on the clover in 1924. Considerable gains were also secured on the corn and oats crops, as is evidenced by the yields of oats secured in 1918 and 1923, and the increases in corn in 1921 and 1922.

The application of rock phosphate or acid phosphate with the manure and lime increased the yields of the various crops in most seasons. In general the acid phosphate showed up very much better than the rock phosphate. The effect of the acid phosphate appeared most definitely on the clover in 1919, on the oats in 1923 and on the clover in 1924. In the latter year the rock phosphate showed very little effect on the clover and it had little effect on the clover in 1919. In some of the other seasons the rock phosphate gave about the same results as the acid phosphate. The complete commercial fertilizer with manure and lime gave somewhat greater effects than acid phosphate in practically all seasons. The differences, however, were in general rather small. Only in the case of the clover in 1919 was there a considerable increase over the acid phosphate from the use of the complete commercial fertilizer. In 1924, the acid phosphate proved quite as effective on the clover as did the complete commercial fertilizer.

Slight increases in crop yields were secured from the application of the crop residues in practically all seasons. Differences were not large but rather definite. The use of lime with the crop residues proved of value in a few cases.

TABLE XIV. FIELD EXPERIMENT—CARRINGTON LOAM—BLACK HAWK COUNTY. JESUP FIELD—SERIES II

Plot No.	Treatment	1918 <sup>1</sup> oats bu. per A.	1919 clover tons per A.	1920 <sup>2</sup> timothy and clover tons per A.	1921 corn bu. per A.	1922 corn bu. per A.	1923 <sup>3</sup> oats bu. per A.	1924 clover tons per A.
1	Check .....	71.9	1.17	0.50	58.7	51.4	31.7	0.92
2	Manure .....	71.6	2.08	0.85	72.8	65.6	29.4	1.06
3	Manure+lime .....	83.1	1.92	1.20	77.6	71.1	37.3	1.26
4	Manure+lime+rock phosphate .....	81.8	1.86	1.15	78.1	73.4	41.8	1.29
5	Manure+lime+acid phosphate .....	76.1	2.22	1.12	75.5	73.4	45.3	1.65
6	Manure+lime+com- plete commercial fertilizer .....	77.2	2.80	1.25	78.7	77.6	44.2	1.60
7	Check .....	60.8	1.38	0.47	54.0	53.7	34.0	0.58
8	Crop residues .....	64.0	1.36	0.52	56.5	56.0	38.3	0.88
9	Crop residues+lime ..	64.9	1.15	0.42	46.4	52.0	36.3	1.15
10	Crop residues+lime+ rock phosphate ....	63.6	1.53	0.42	60.8	60.8	38.7	1.23
11	Crop residues+lime+ acid phosphate ....	62.5	1.53	0.60	67.6	62.6	38.3	1.62
12	Crop residues+lime+ complete commer- cial fertilizer .....	75.7	1.77	0.70	72.8	70.2	38.3	1.67
13	Check .....	67.8	1.20	0.65	60.2	55.4	34.0	1.18

<sup>1</sup>Three and one-half tons lime applied.

<sup>2</sup>Plots 9 and 10 in swale and poorly drained.

<sup>3</sup>Oats thin—dry season.



The influence of lime did not appear very definitely in these results. Beneficial effects on the clover in 1924, however, were very clearly shown.

The application of rock phosphate or acid phosphate with crop residues and lime brought about considerable increases in crop yields in several cases. The two phosphates gave the same increases in the yields of clover in 1919 but in 1924 the acid phosphate had a very small effect. In 1921 and 1922, the acid phosphate showed up somewhat better than the rock phosphate. In 1920, the acid phosphate gave a slight increase in the yield of timothy and clover while the rock had no effect. The complete commercial fertilizer had a somewhat larger effect than the acid phosphate in practically all cases. The differences, however, were not very large except with the clover in 1919.

The results of this experiment clearly indicate the beneficial effect of the use of manure, lime and phosphorus fertilizers on the Carrington loam. Large increases in crop yields follow the application of manure and liberal amounts of this material should certainly be used on this type. The type is acid in reaction and in need of lime and if the best growth of general farm crops is to be secured the use of lime is very necessary. The increases from the additions of lime are particularly large in the case of the legume crops. Beneficial effects are also secured on the other general farm crops grown in the rotation.

A phosphorus fertilizer should be used on this soil, and increased crop yields will undoubtedly be secured from the application of rock phosphate or acid phosphate. Acid phosphate seems to be somewhat preferable for use but in several cases the rock phosphate showed up very well. It would seem, therefore, that it would be very desirable for farmers to test the use of both materials under their own conditions in order that they may choose that one which will bring about the largest effect on their particular soil. The use of a complete commercial fertilizer cannot be recommended in general for this soil, altho considerable beneficial effects are sometimes secured. Tests are very desirable before there is a large use of any complete fertilizer. It would seem that acid phosphate might be quite effective in bringing about crop increases and as it is less expensive the material would be more desirable for general use.

#### THE ELDORA FIELD

The results secured on the Carrington loam on the Eldora field, series 100, in Hardin County, are given in table XV. This experiment was begun in 1915 and the results are now available for a 10 year period. Yields have been secured for five crops of corn, three crops of oats and two crops of clover. The application of manure brought about an increase in crop yields in practically all cases. In the first year, the yields were somewhat abnormal and no increase appeared. The yields of corn in 1918, 1919 and 1922 were very much increased by manure. The oats showed distinct gains and increases were particularly noticeable in 1916 and 1924. The application of lime with the manure increased the clover yields in 1917 and showed some effects on the corn and oats in other years, but no large gains were noted.

The rock phosphate and acid phosphate with the manure and lime brought about large increases in the yields of all the crops with the exception of the rock phosphate on the corn in 1922 and 1923. The effect of the two phosphates on the clover in 1921 was particularly noticeable. The acid phosphate showed an unusually large effect on the corn in 1918, and on the oats in 1924. It also gave large effects on the oats in 1916 and on the corn in 1919 and 1922. In general the acid phosphate seemed to show a much more pronounced effect than did the rock phosphate. The complete commercial fertilizer had larger effects than the acid phosphate on the clover in 1917 and 1921 and on the corn in 1923. Differences, however, were not very large in any of these cases and in several instances the increases from the complete commercial fertilizer were smaller than those brought about by the acid phosphate.

TABLE XV. FIELD EXPERIMENT—CARRINGTON LOAM—HARDIN COUNTY.  
ELDORA FIELD. SERIES 100.

Plot No.	Treatment	1915 <sup>1</sup> Corn bu. per A.	1916 Oats bu. per A.	1917 Clover tons per A.	1918 Corn bu. per A.	1919 <sup>2</sup> Corn bu. per A.	1920 <sup>3</sup> Oats bu. per A.	1921 <sup>4</sup> Clover tons per A.	1922 Corn bu. per A.	1923 <sup>5</sup> Corn bu. per A.	1924 Oats bu. per A.
1	Check .....	47.5	40.0	1.19	46.4	33.9	42.8	1.75	64.3	41.5	59.6
2	Manure .....	38.5	50.0	1.36	55.8	52.5	49.6	1.65	67.2	40.0	69.1
3	Manure+lime ....	40.8	40.0	1.53	52.2	50.6	56.9	1.50	69.9	38.2	70.4
4	Manure+lime+ rock phosphate.	53.3	46.0	1.78	48.9	58.8	57.7	2.30	66.4	41.8	71.5
5	Manure+lime+ acid phosphate.	53.9	53.0	1.87	68.8	61.1	60.3	2.55	73.6	44.8	79.4
6	Manure+lime+ complete com- mercial ferti- lizer .....	52.2	53.6	2.04	60.7	57.9	59.8	2.65	70.7	50.4	78.0
7	Check .....	35.3	33.8	1.44	56.8	35.4	43.1	1.40	61.7	34.9	52.6
8	Crop residues ....	37.2	33.9	1.36	53.3	39.6	38.7	1.40	62.2	33.0	55.9
9	Crop residues+ lime .....	37.3	30.0	1.28	60.3	39.2	50.2	1.55	64.3	41.5	71.6
10	Crop residues+ lime+rock phosphate .....	38.7	33.3	1.70	62.2	44.0	52.2	2.40	73.6	45.6	79.5
11	Crop residues+ lime+acid phosphate .....	46.8	46.6	1.87	65.3	46.0	55.7	3.00	82.2	43.9	83.4
12	Crop residues+ lime+complete commercial fer- tilizer .....	35.0	50.0	1.70	63.7	41.6	67.2	2.85	70.0	45.9	74.2
13	Check .....	28.8	33.8	1.23	58.3	35.0	39.4	2.00	65.0	38.2	58.0

<sup>1</sup>Limed—3 tons per acre, fall, 1914.<sup>2</sup>Dry season—yields low.<sup>3</sup>Plots limed in spring.<sup>4</sup>Much sweet clover on plot 13.<sup>5</sup>Corn down badly; dry season.

There was little effect from the crop residues on any of the crops grown. Small increases were noted in only a few cases. The lime with the crop residues brought about some beneficial effects, having the most pronounced influence on the clover in 1920 and on the clover in 1921. The oats in 1924 showed a very large increase from the lime. Corn in 1923 also showed a considerable increase.

The rock phosphate and acid phosphate gave large crop gains in practically all cases. Again the influence was the greatest on the clover in 1921. Corn in 1922 was increased to a very large extent. The oats in 1924 were increased in a very pronounced way. The acid phosphate gave larger increases than the rock phosphate every year except in 1923. In several cases the gains over rock phosphate were very pronounced. The complete commercial fertilizer showed larger effects than did the acid phosphate in three cases, having a very pronounced influence on the oats in 1920. In most years, however, the acid phosphate proved superior.

The yields secured on series 200 of the Eldora field are recorded in table XVI. Yields have been secured on this field since 1917 and there are records for eight crops. The manure brought about a large increase in the yields of all the crops except the corn in 1923 and 1924. The effect on the oats in 1921 and on the clover in 1922 were pronounced. The addition of lime with the manure gave further increases in crop yields in most cases. The increases were not large but rather definite.

The rock phosphate and acid phosphate with the manure and lime proved of considerable value on the crops grown. The increases were particularly notice-



able on the clover in 1922. The acid phosphate was superior to the rock phosphate on four of the crops while rock surpassed it in three cases. In one instance the yields were the same from the two materials. The complete commercial fertilizer had a larger effect than the acid phosphate in 1921, 1922 and 1923. There was less effect from this material in the first four years of the test. The differences were hardly large enough on the average to warrant preference being given to the complete commercial fertilizer.

The crop residues showed little effect on the crop yields in most instances. The addition of lime with the residues brought about increases in the yields in most cases. The yield on plot 9 in 1922 was evidently abnormal as clover usually responds very definitely to the application of lime. The rock phosphate and acid phosphate gave distinct increases in crop yields except in 1921 and 1923. The yields were increased to a large extent in 1922. The complete commercial fertilizer showed a somewhat larger effect than the acid phosphate thru the last four years of the experiment. The differences were not large, however, except on the corn in 1920.

The results secured on these two experiments on the Eldora field indicate quite definitely the beneficial effect of the manure, lime and phosphorus on the Carrington loam. Large increases in crop yields are always secured from the application of manure to this soil. The addition of lime proved of value in most cases. The type is acid and the need of lime is particularly evidenced on the legume crops grown. The application of acid phosphate proved profitable in many cases and rock phosphate often showed considerable crop increases. Further experimental results are necessary before definite recommendation can be made regarding the use of acid phosphate and rock phosphate. It is recommended that tests be carried out on individual fields of these two phosphorus fertilizers. The complete commercial fertilizer often brought about considerable gains in crop growth, but in general acid phosphate seemed to be quite as effective in increasing crop yields and it would therefore be more profitable for general use.

TABLE XVI. FIELD EXPERIMENT—CARRINGTON LOAM—HARDIN COUNTY.  
ELDORA FIELD. SERIES 200.

Plot No.	Treatment	1917 <sup>1</sup> Oats bu. per A.	1918 <sup>2</sup> Clover tons per A.	1919 Corn bu. per A.	1920 <sup>3</sup> Corn bu. per A.	1921 Oats bu. per A.	1922 <sup>4</sup> Clover tons per A.	1923 <sup>5</sup> Corn bu. per A.	1924 Corn bu. per A.
1	Check .....	60.1	0.54	46.4	60.9	26.6	1.17	41.5	31.6
2	Manure .....	66.4	0.90	50.0	62.5	38.0	1.38	37.6	30.3
3	Manure+lime .....	65.7	1.00	51.8	65.6	41.8	1.31	40.0	23.3
4	Manure+lime+rock phosphate.	72.6	1.85	53.6	71.8	50.3	2.06	42.1	30.0
5	Manure+lime+acid phosphate.	85.5	1.51	57.2	68.7	48.7	2.57	46.6	30.0
6	Manure+lime+complete commercial fertilizer .....	80.0	1.48	51.7	59.3	54.6	2.61	53.2	28.1
7	Check .....	62.0	0.45	48.8	42.1	36.9	1.88	38.2	18.3
8	Crop residues .....	61.8	0.41	50.7	35.9	32.3	1.80	36.9	18.3
9	Crop residues+lime .....	63.0	0.47	50.8	35.9	29.2	1.41	43.2	19.0
10	Crop residues+lime+rock phosphate .....	69.2	0.49	60.0	45.3	22.0	2.13	40.5	19.7
11	Crop residues+lime+acid phosphate .....	67.6	0.74	62.5	48.4	32.2	2.32	40.0	21.7
12	Crop residues+lime+complete commercial fertilizer .....	66.4	0.51	55.3	59.3	37.2	2.60	46.6	21.7
13	Check .....	60.0	0.38	52.1	48.4	28.6	1.68	31.5	10.0

<sup>1</sup>Three tons lime in 1916.

<sup>2</sup>Crop poor—dry season.

<sup>3</sup>Plots 5, 6, 7, 8, 9 poor due to wet spring. Limed 3 tons per acre.

<sup>4</sup>Poor stand on 1, 2 and 3.

<sup>5</sup>Dry season—poor stand.

## THE PRINCETON FIELD

The results secured on the Clinton silt loam on the Princeton field in Scott County are given in table XVII. The applications of manure brought about increased crop yields in most seasons on this soil type. The corn in 1920 and in 1923 showed very pronounced increases. The clover in 1922 was benefited materially by the addition of manure. The application of lime with the manure brought about further increases in practically all cases. The beneficial effects of the lime were evidenced not only on the clover grown in the rotation but also on the corn, oats and wheat crops.

The use of rock phosphate or acid phosphate with the manure and lime increased crop yields in practically all cases. In some instances the rock phosphate gave somewhat larger effects on the crop yields than did the acid phosphate, but in other seasons acid phosphate had a very much larger effect than the rock phosphate. In 1924 the yield of oats was greatly increased by the use of acid phosphate while the rock phosphate had very little effect. In 1921, the oats crop was increased more by the acid phosphate. In 1919 and 1920, the rock phosphate showed more effect than did the acid phosphate. The difference in the effect of these two phosphate fertilizers was not very large in any season. The application of a complete commercial fertilizer showed very much the same effect as the acid phosphate in most cases. In one or two seasons there was a larger effect on crop yields from the complete fertilizer but the differences were not great and in some cases the acid phosphate showed up better than did the complete commercial fertilizer.

Little effects were evidenced from the crop residues on any of the crops grown. In one or two seasons small increases were secured. The application of lime with the crop residues brought about pronounced gains in crop yields in many seasons. The increase on the corn in 1919 was particularly noticeable. The clover in 1922 showed a very large increase in yield and the corn in 1923 was increased considerably.

The application of acid phosphate or rock phosphate with the crop residues

TABLE XVII. FIELD EXPERIMENT—CLINTON SILT LOAM—SCOTT COUNTY.  
PRINCETON FIELD—SERIES I

Plot No.	Treatment	1918 <sup>1</sup> Winter wheat bu. per A.	1919 <sup>2</sup> Corn bu. per A.	1920 <sup>3</sup> Corn bu. per A.	1921 Oats bu. per A.	1922 <sup>4</sup> Clover tons per A.	1923 Corn bu. per A.	1924 Oats bu. per A.
1	Check .....	40.7	69.3	61.8	27.7	1.41	54.0	65.8
2	Manure .....	37.4	67.6	68.3	28.4	1.93	63.2	64.8
3	Manure+lime .....	43.0	68.2	70.6	32.1	2.13	70.2	65.3
4	Manure+lime+rock phosphate .....	47.4	67.8	73.5	31.9	2.25	72.5	63.1
5	Manure+lime+acid phosphate .....	45.2	64.0	70.8	35.1	2.29	73.2	75.1
6	Manure+lime+complete commercial fertilizer .....	37.3	68.4	73.0	36.4	2.34	68.1	71.9
7	Check .....	31.7	57.0	57.5	24.4	1.60	53.0	62.2
8	Crop residues .....	....	52.6	58.6	29.6	1.47	55.2	66.4
9	Crop residues+lime .....	31.7	62.4	67.3	29.7	2.14	61.8	65.6
10	Crop residues+lime+rock phosphate .....	35.0	64.1	68.7	29.8	2.28	65.0	63.4
11	Crop residues+lime+acid phosphate .....	31.7	66.6	61.5	31.1	2.18	68.0	75.1
12	Crop residues+lime+complete com- mercial fertilizer .....	36.2	65.2	69.5	30.8	....	70.1	73.5
13	Check .....	28.2	59.3	59.5	25.5	....	58.6	54.4

<sup>1</sup>Three tons lime applied Aug., 1917. Yield on plot 8 error.

<sup>2</sup>Clover poor and plowed up.

<sup>3</sup>Plot 11 many missing hills, low yield.

<sup>4</sup>Yields on plots 12 and 13 lost due to error.



and lime proved beneficial on the crops grown in many cases. In some seasons the rock phosphate was a little better than the acid phosphate and in other cases the acid phosphate proved superior. In no instance was there a very large difference in the influence of these two fertilizers except on the oats in 1924 when the acid phosphate brought about a very large increase in the yield and the rock phosphate showed practically no effect. The complete commercial fertilizer had about the same effect as the acid phosphate in most cases. It showed up better on the winter wheat in 1918 and on the corn in 1920, but the differences were not large. In general it would not seem that the increases from the complete commercial fertilizer were sufficiently greater than those brought about by the acid phosphate to warrant the application of the complete material.

It is evident from the data given that the Clinton silt loam will be made much more productive by proper applications of farm manure, lime and a phosphorus fertilizer. The application of manure is of particularly large value on this type and induces considerable increases in the yields of general farm crops. The type is acid in reaction and the application of lime is very desirable both in connection with manure and with crop residues under the grain system of farming. Not only are large increases of leguminous crops obtained but other general farm crops are increased considerably.

The application of a phosphate fertilizer will prove of large value in many cases on this soil. It seems possible that acid phosphate might be more desirable for use inasmuch as the data indicate in some cases superior value for the acid phosphate, but definite conclusions cannot be drawn inasmuch as rock phosphate often proves quite as useful as acid phosphate. Tests on individual farms with the two phosphates are very desirable. Little difference was evidenced between the relative effect of the two phosphates under the two systems of farming whether used with manure or with crop residues. The complete commercial fertilizer gave increases in crop yields in many cases but the gains were not sufficiently greater than those from acid phosphate to warrant the use of the more expensive material. Tests should be carried out under individual farm conditions before a complete commercial fertilizer is employed on this soil.

#### THE BLUEGRASS FIELD

The results secured on the Muscatine silt loam on the Bluegrass Field in Scott County are given in table XVIII. While this soil type is well supplied with organic matter and black in color, large increases in crop yields are frequently secured from the application of farm manure. In all cases the results secured from this field show increased crop yields from the addition of manure. The beneficial effect of manure is evidenced particularly on the clover in 1920, but increases were secured on the various corn, oats and wheat crops grown. The application of lime along with the manure increased crop yields further in all cases. The clover in 1920 was benefited greatly from the use of lime. There were pronounced increases also, however, in the corn in 1921 and 1922 and a very large increase in the oats crop in 1923.

The application of rock phosphate or acid phosphate with the manure and lime increased crop yields in several instances. The clover in 1924 showed the greatest effect from the use of these phosphorus carriers, both materials effecting very pronounced increases. The wheat in 1919 was increased considerably by the acid phosphate. The complete commercial fertilizer with the manure and lime gave about the same effect as acid phosphate in practically all cases. It showed up a little better on the oats in 1923 and on the clover in 1924, but neither of the differences were large.

The crop residues had little effect on the yields of the various crops grown. Small increases were secured in one or two cases. The addition of lime with the crop residues showed a pronounced beneficial effect on practically all of the crops. An increase was noted particularly on the clover in 1920 and the clover

TABLE XVIII. FIELD EXPERIMENT—MUSCATINE SILT LOAM—SCOTT COUNTY.  
BLUEGRASS FIELD—SERIES I

Plot No.	Treatment	1918 <sup>1</sup> Corn bu. per A.	1919 <sup>2</sup> Spring Wheat bu. per A.	1920 <sup>3</sup> Clover tons per A.	1921 Corn bu. per A.	1922 Corn bu. per A.	1923 Oats bu. per A.	1924 Clover tons per A.
1	Check .....	74.1	11.5	1.57	54.7	62.9	27.2	1.62
2	Manure .....	75.2	12.4	1.92	57.8	68.8	30.6	1.71
3	Manure+lime .....	77.0	13.3	2.37	66.1	74.1	47.6	1.81
4	Manure+lime+rock phosphate.....	73.3	13.1	2.35	67.5	72.5	46.4	2.30
5	Manure+lime+acid phosphate.....	71.4	18.9	2.37	63.5	74.1	45.3	2.30
6	Manure+lime+complete commercial fertilizer .....	73.2	14.4	2.35	64.0	73.4	49.8	2.44
7	Check .....	71.6	11.3	2.22	56.5	70.6	41.8	1.44
8	Crop residues .....	69.6	9.6	2.05	59.2	66.9	39.7	1.54
9	Crop residues+lime .....	66.9	11.6	2.25	60.8	70.4	46.4	1.69
10	Crop residues+lime+rock phosphate.	73.8	13.9	2.35	66.7	73.8	45.3	2.17
11	Crop residues+lime+acid phosphate.	65.6	15.0	2.37	63.2	66.9	47.6	2.26
12	Crop residues+lime+complete com- mercial fertilizer .....	62.9	15.0	2.35	64.8	70.1	48.7	2.29
13	Check .....	66.9	7.6	2.17	61.3	64.3	30.6	1.45

<sup>1</sup>Lime applied, 3½ tons per acre in May. Growth of smartweed reduced crop on plots 11 and 12.<sup>2</sup>Crop injured by blight.<sup>3</sup>Lime applied in fall.

in 1924. There was a considerable increase from the oats in 1923. Several of the corn crops showed large gains from the addition of lime.

The application of rock phosphate or acid phosphate with the crop residues and lime generally increased the crop yields. Again the largest beneficial effect from the phosphorus carriers was shown on the clover in 1924. Increases were also secured on the same crop in 1920 and the wheat crop in 1919 was increased. The relative effects of the two phosphorus carriers was variable. In some cases the rock phosphate showed up a little better than the acid phosphate while in others the latter material caused the largest increases. The complete commercial fertilizer with the crop residues and lime gave about the same results as the acid phosphate in most cases. It showed up a little better on the corn in 1922 but had less effect in that season than did the rock phosphate.

Crop yields on the Muscatine silt loam may evidently be increased considerably thru proper applications of manure, lime and a phosphorus fertilizer. The beneficial effect of manure is apparent on the soil even tho it is high in organic matter and black in color. The beneficial effects of applications of lime are very clearly shown by the data and large increases in crop yields are ordinarily secured. Leguminous crops are particularly benefited by the use of lime as this type is acid. Increases are also secured in many cases on other crops grown.

The value of applications of a phosphate fertilizer to this type are very definitely indicated. Whether acid phosphate or rock phosphate should be employed, however, can only be ascertained by conducting tests of the two materials on individual farms. Sometimes acid phosphate seems preferable for use but in other cases rock phosphate gives very satisfactory returns. It does not seem probable that a complete commercial fertilizer would be as desirable for use on this soil as the application of acid phosphate, inasmuch as the increases in crop yields are less definite in some cases and where larger increases are brought about by the complete fertilizer, they are not sufficiently greater to warrant the larger cost of the material over acid phosphate.



## AVERAGE RESULTS ON THE TAMA SILT LOAM

Average results from all the field experiments in the state on the Tama silt loam are given in table XIX. The application of manure increased both the corn and oats yields. Lime applied with the manure brought about further increases with both of these crops. The addition of rock phosphate or acid phosphate with the manure and lime gave increases in both crops, rock phosphate showing slightly larger effects than acid phosphate. The differences were not very definite, however, and conclusions regarding the relative value of the two phosphate fertilizers cannot be drawn. The complete commercial fertilizer had less effect than the phosphates on the corn but gave somewhat greater effects on the oats.

Crop residues showed very little effect on the crops grown. The addition of lime with the crop residues proved of considerable value. Both phosphates brought about increases in the yields of corn and oats. In this case the acid phosphate showed up somewhat better than the rock phosphate. The complete commercial fertilizer had less effect than the phosphates on the corn but showed somewhat larger effect on the oats.

These average figures indicate quite definitely that phosphate fertilizers may be applied with profit to the Tama silt loam. Whether rock phosphate or acid phosphate should be employed, however, cannot yet definitely be stated. The acid phosphate seemed to give larger effects when used with the crop residues and lime under the grain system of farming. The rock phosphate was a little better with the manure under the livestock system. The differences, however, were hardly large enough to be distinct. The use of a complete commercial fertilizer on this type is not generally recommended. It seems that quite as profitable results may be secured from the use of acid phosphate. Tests of any complete commercial fertilizer should be carried out on a small scale before the material is applied to any large area.

TABLE XIX. TAMA SILT LOAM. AVERAGE CROP YIELDS AND INCREASES DUE TO FERTILIZER TREATMENT

Iowa Experiment Fields

Treatment	Corn*		Oats*	
	Bu. per acre	Increase from treatment bu. per acre	Bu. per acre	Increase from treatment bu. per acre
Check .....	63.3	...	46.0	...
Manure .....	69.6	6.3	49.4	3.4
Manure+lime .....	71.8	8.5	56.3	10.3
Manure+lime+rock phosphate.....	77.7	14.4	58.6	12.6
Manure+lime+acid phosphate .....	75.3	12.0	56.7	10.7
Manure+lime+complete commercial fertilizer.....	73.7	10.4	62.9	16.9
Crop residues .....	69.7	6.4	47.0	1.0
Crop residues+lime .....	71.8	8.5	57.9	11.9
Crop residues+lime+rock phosphate .....	74.4	11.1	58.9	12.9
Crop residues+lime+acid phosphate .....	75.7	12.4	63.3	17.3
Crop residues+lime+complete commercial fertilizer....	72.7	9.4	68.0	22.0

\*The corn yields are the averages of 3 years' results on 2 fields.

\*The oats yields are the averages of 2 years' results on 2 fields.

## AVERAGE RESULTS ON THE CARRINGTON LOAM

The average results secured on all the experiment fields on the Carrington loam are given in table XX. The application of manure to this soil induced large increases in the yields of corn, oats and clover. The use of lime with the manure was of considerable value on all three crops. The increases were quite as large in the case of the corn and the oats as in the case of the clover. Rock phosphate or acid phosphate with the manure and lime gave profitable increases in the various crops grown, the results being very much the same on the corn and oats. In the case of the clover, however, the acid phosphate was much more effective than the rock phosphate. The complete commercial fertilizer brought about increases which were very similar to those occasioned by the phosphates on the corn and oats. The results were very much the same as in the case of the acid phosphate with the clover crop.

The various crops were influenced to only a slight extent by the crop residues treatment. The use of lime again proved of distinct value. The two phosphates increased the crop yields, the acid phosphate proving superior on the corn in every instance. The complete commercial fertilizer gave slightly larger effects than the acid phosphate. Apparently from these results, the Carrington loam may be made more productive by applications of manure, lime and a phosphate fertilizer. The experiments on individual fields on this same soil type have shown very similar results to those given in the tests. The large value of manure and lime on the soil is evidenced not only in the experiments referred to above, but by much farm experience. Acid phosphate seems to be superior to rock phosphate in some cases but definite conclusions regarding the merits of the two materials should not be drawn. Tests on individual fields are recommended before there is any extensive application of either phosphate fertilizer. The value of the complete commercial fertilizer does not seem to be sufficiently great to warrant its use in preference to acid phosphate.

TABLE XX. CARRINGTON LOAM. AVERAGE CROP YIELDS AND INCREASES DUE TO FERTILIZER TREATMENT

Iowa Experiment Fields

Treatment	Corn*		Oats*		Clover*	
	Average yield bu. per acre	Increase for treatment bu. per acre	Average yield bu. per acre	Increase for treatment bu. per acre	Average yield tons per acre	Increase for treatment tons per acre
Check .....	51.9	...	43.6	...	1.25	...
Manure .....	58.8	6.9	49.6	6.0	1.38	0.13
Manure+lime .....	62.6	10.7	53.0	9.4	1.57	0.32
Manure+lime+rock phosphate .....	66.0	14.1	62.3	18.7	1.97	0.72
Manure+lime+acid phosphate .....	66.3	14.4	60.8	17.2	2.27	1.02
Manure+lime+complete commercial fertilizer .....	66.8	14.9	62.4	18.8	2.29	1.04
Crop residues .....	54.7	2.8	47.3	3.7	1.37	0.12
Crop residues+lime .....	57.5	5.6	49.3	5.7	1.41	0.16
Crop residues+lime+rock phosphate..	61.8	9.9	51.2	7.6	1.80	0.55
Crop residues+lime+acid phosphate...	62.4	10.5	52.7	9.1	1.94	0.69
Crop residues+lime+complete com- mercial fertilizer .....	64.2	12.3	58.2	14.6	2.02	0.77

\*Corn yields averaged from 20 crops on 10 fields, oats from 9 crops on 5 fields and clover from 15 crops on 9 fields.



## NEEDS OF JASPER COUNTY SOILS AS INDICATED BY LABORATORY, GREENHOUSE AND FIELD TESTS

The laboratory, greenhouse and field experiments discussed earlier in this report, have indicated the general treatments which would be very desirable for use in Jasper County. Special treatments are often required for soils which are more or less abnormal and these will be mentioned later under the discussion of the individual soil types. There are certain general recommendations which can be given, however, because they are applicable to the leading soil types of the county. The treatments recommended are based on the experimental work carried out on the same soil types which occur extensively in Jasper County. The recommendations are based also on experience and no suggestions are offered which have not been shown to be of value by practical farm experience. While the field experiments which have been described are located in other counties, the soil types are the same as those which occur extensively on the uplands in Jasper County and the results may be considered quite definitely to indicate the needs of the same soils in this county.

### LIMING

The soils of Jasper County, with the exception of the Webster silty clay loam on the uplands, and the Lamoure silty clay loam on the bottomlands, are acid in reaction and hence they are in need of lime. In some areas the surface soil of the Webster silty clay loam may not show a lime content and if an acidity is evidenced when the soil is tested, applications of lime would be desirable even on this type. In addition to the two soils mentioned which contain lime in the surface, several others show a lime content in the subsurface soil or in the subsoil. These include the Clarion loam, the Clarion fine sandy loam, the Webster loam and the Webster clay loam. These types are all acid in the surface soil, however, and the needs of the surface soil are considered to show most accurately the lime requirement of the soil.

There is very little movement of lime upward in the soil but on the contrary a considerable removal of the material thru leaching in the drainage water as well as thru utilization by crop growth. The fact that lime is present in the subsoil does not mean, therefore, that applications of lime will not be needed if the surface soil is acid, for the best early growth of legumes such as clover and alfalfa.

The results given earlier in this report, which set forth the limestone requirements of the various soil types, indicate only roughly the lime needs of the various soils. The lime requirement of different soils varies widely and even soils of the same type will frequently show a difference in lime requirement in different fields. It is very essential, therefore, if the proper application of lime is to be made, that the soil in any particular area be tested for its reaction and lime requirement. Farmers may test their own soils for acidity but they will usually find it more satisfactory to send a small sample to the Soils Section of the Iowa Agricultural Experiment Station and have it tested free of charge.

In many of the experiments described earlier in this report, very striking crop increases were noted from the application of lime to acid soils of the county. The beneficial effects have been evidenced on the Tama silt loam, the Clinton silt loam, the Carrington loam and the Muscatine silt loam, the leading upland types in the county. Similar large increases would undoubtedly be secured on many of the other soils of the county. Farm experiences with lime have shown very definite beneficial effects on the yields of general farm crops. Not only are leguminous crops benefited, but increases are secured in the yields of corn, oats and wheat and other farm crops. There is no question but that the use of lime on the acid soils of Jasper County will bring about very profitable effects. Further

information pertaining to the use of lime on soils, losses by leaching, and other points connected with liming, are presented in Extension Bulletin 105 of the Iowa Agricultural Experiment Station. This bulletin also contains a list of the companies prepared to furnish limestone.

### MANURING

Many of the Jasper County soils are not very well supplied with organic matter and some of them are light in color. They are evidently in need of some fertilizing material supplying this constituent. In some of the soils the organic matter apparently is adequate; the soils are dark in color, but even in these cases the supply of organic matter is not excessive and it is very necessary that some fertilizing materials supplying organic matter be applied to these soils at regular intervals if the supply is to be kept up. On those types which are light in color, coarse in texture and quite evidently low in organic matter, the addition of organic fertilizing materials is of particularly large significance.

The use of farm manure is the most important means of building up and maintaining the supply of organic matter in the soils. It is the cheapest and the best fertilizer which can be employed on any farm. Large crop increases are brought about from the use of this material on practically all soils. On the light colored, coarse textured types, the benefits are particularly evidenced but increases are also secured in many cases on heavier soils which are darker in color and apparently better supplied with organic matter.

Greatly increased crop yields have been obtained in many experiments on the Tama silt loam, the Clinton silt loam, the Carrington loam, the Muscatine silt loam, the Grundy silt loam and soils of the Webster series, in field experiments carried out in other counties. While these latter types are higher in organic matter, the use of small amounts of manure is very desirable. On the Webster soils the manure should not be applied preceding the small grain crop, owing to the danger of causing it to lodge. Small amounts applied at other points in the rotation will, however, bring about distinct crop increases. On many of the other soils in the county, particularly the Shelby and the Lindley loams and the sandy types of the Carrington and Clarion series, the benefits from the addition of farm manure would undoubtedly be very large. Similarly on the sandy soils on the terraces, farm manure would have a very large value.

The ordinary application of manure is about 8 to 10 tons per acre once in four years. It is rarely desirable to make a larger application than this except on light colored coarse-textured soils or in areas where truck crops or garden crops are to be grown. On average upland soils where general farm crops are grown, the largest increases in crop yields per ton of manure are generally secured with an application of 8 to 10 tons per acre.

The proper utilization of all the crop residues is very important as an aid in maintaining the supply of organic matter in the soils and farmers should see to it that these materials are all returned to the land. Very often the crop residues are burned and when this is practiced there is an actual destruction of valuable fertilizer constituents. On the livestock farms the residues may be used for feed or bedding and returned to the land with the manure. On the grain farms they may be stored and allowed to decompose partially before being applied, or they may be applied directly to the land.

On many livestock farms the supply of manure is inadequate to permit of an application of 8 to 10 tons per acre once in four years. In such cases it is important that leguminous crops be used as green manures to supplement the farm manure. On the grain farm where little or no farm manure is produced, green manuring is a very important farm practice, and must be used as a substitute for farm manure. Legumes are always more desirable for use as green manures because they not only supply organic matter but when well inoculated they take up nitrogen from the atmosphere and hence serve to increase the supply of nitro-



gen in the soil when they are turned under as green manures. There are undoubtedly many cases in Jasper County where the use of leguminous crops as green manures would bring about very large beneficial effects. This is particularly true in the case of some of the coarse textured, light colored soils, where the incorporation of organic matter is more necessary. In following this practice, however, care should be exercised as undesirable results may occur if conditions in the soil do not permit of the best decomposition of the green material.

### THE USE OF COMMERCIAL FERTILIZERS

The soils of Jasper County in general are rather poorly supplied with phosphorus. Some of the types are very low in this constituent and it seems evident that phosphorus fertilizers will certainly be needed on the soils of this county in the very near future. There is evidence, however, from the greenhouse and field experiments described earlier in this report, that the application of a phosphate fertilizer might prove of large value at present. Large increases in crop yields were often obtained from the use of one or the other of the phosphate fertilizers.

While both acid phosphate and rock phosphate have been tested in the experiments referred to, it has not yet been possible to draw definite conclusions regarding the relative value of these two materials on the soils of the county. In many cases acid phosphate seems to be somewhat more effective while in other instances rock phosphate shows up quite as well. Acid phosphate is somewhat more expensive than rock phosphate but it is applied in smaller amounts, usually at the rate of 150 to 200 pounds per acre annually. It supplies the element phosphorus in an immediately available form and hence may have quicker effects in increasing crop yields. Rock phosphate, on the other hand, is applied at the rate of one ton per acre once in a four-year rotation and it is less expensive, but the phosphorus present in the material must be changed into an available form before it can be utilized by crops. Hence the rock phosphate cannot be expected to show as large an immediate effect. Usually the largest influence of the rock phosphate is shown on the second crop after the application.

At the present time a choice between rock phosphate and acid phosphate for the soil conditions in the county in general, cannot be made. It is urged that farmers test the two phosphates on their own soils and thus determine the response of their particular soils to phosphorus and which fertilizer will prove the more profitable. Simple tests can be carried out readily on any farm. Directions which may be followed in carrying out such tests are given in Circular 82 of the Iowa Agricultural Experiment Station.

The soils of Jasper County are in general fairly well supplied with nitrogen but in a few cases, on the coarse textured light-colored soils, there is no large supply of this element and there may even be a deficiency. In all cases, however, applications of some fertilizing material supplying nitrogen must be made regularly to all the soils of the county if the supply is to be kept up. On many of the types the addition of nitrogen would be of considerable value at the present time.

On the livestock farms the supply of nitrogen in the soil may be more nearly maintained thru the proper preservation and utilization of all the farm manure produced. The supply cannot be entirely kept up in this way, however, and building up the content of nitrogen in the soil thru the use of farm manure is quite impossible on the average farm because not enough manure is produced to permit applying very large amounts to any particular areas. The use of crop residues aids considerably in keeping up the nitrogen in the soil by returning considerable amounts of the element which have been removed by the crops grown. Thoro utilization of all the crop residues is very necessary on the livestock farm and also on the grain farm in order to aid in maintaining the nitrogen content of the land.

On the grain farm where little or no farm manure is produced, leguminous

crops should be used as green manures in order to maintain the supply of nitrogen in the soil. On the livestock farm, green manuring should also be practiced when it is desirable to increase the content of nitrogen in the land and also as an aid to maintaining the supply. Leguminous crops should always be used for green manuring purposes because when inoculated they take a large part of their nitrogen from the atmosphere, hence they serve to increase the content of the soil when they are turned under as green manure. There are many cases in Jasper County where the proper utilization of legumes as green manures would prove of large value.

The general use of commercial nitrogenous fertilizers cannot be recommended in Jasper County because the nitrogen supply in the soils may be maintained quite as satisfactorily and more economically by the proper utilization of leguminous green manures, farm manure and crop residues. Small amounts of nitrates may be used sometimes as top dressings with profit but for general farm crops it is unlikely that such materials would prove as profitable as the use of leguminous green manures.

Previous analyses have indicated that the soils of Jasper County are very well supplied with potassium and it would not seem likely, therefore, that commercial potassium fertilizers would prove of value on these soils. If conditions are maintained so that the potassium is changed into an available form with sufficient rapidity, crops should be well supplied with this element for many years to come. Potassium fertilizers are not recommended, therefore, for general use in the county. Tests should certainly be carried out on small areas before a potassium fertilizer is applied to a large area. Small amounts of these materials as top dressings might prove desirable in some cases.

Comparative tests of the value of certain complete commercial fertilizers with acid phosphate and rock phosphate have not indicated any superiority of the complete fertilizers over the phosphates. Therefore, at the present time the use of a complete commercial fertilizer does not seem desirable on any of the soils of Jasper County. The potassium content of the soils is high, while the nitrogen content may be deficient, nitrogen can be more cheaply supplied thru the use of leguminous green manure crops, hence the value of the complete commercial fertilizer lies in the phosphate content. It is apparent, therefore, that acid phosphate might show more economic returns than a complete fertilizer, because it is less expensive and supplies phosphorus quite as satisfactorily as does the complete commercial fertilizer. Comparative tests of any brand of a complete commercial fertilizer should be carried out in comparison with acid phosphate on a small area before any large use of the complete fertilizer is made. If sufficiently greater crop increases are secured to warrant the greater cost of the complete fertilizer there is no objection to its employment.

### DRAINAGE

The natural drainage system of Jasper County is very well developed as indicated earlier in this report. The map has shown very clearly the rather extensive natural drainage system of the county as a whole. Only in the northwestern part of the county in the level areas of drift soils, is there any large evidence of a lack of drainage. There are many cases in the county, however, where drainage is not entirely satisfactory in certain small limited areas within some of the soil types. On the uplands the lack of drainage is apparent on the Webster loam, the Webster clay loam and the Webster silty clay loam, those level drift soils which are found largely in the northwestern corner of the county. On the loessial uplands the need for drainage is evidenced in many areas of the Muscatine silt loam and the Grundy silt loam, the types occurring on the more level areas of uplands. Drainage is also inadequate in small areas of the Marion silt loam. On the terraces drainage is very well established except in the case of the Bremer soils. The bottomland types are poorly drained in



some cases, particularly with the heavier textured soils, but in most of these cases the soils are more in need of protection from overflow, and the installation of tile would be of value only after the soils had been properly protected from the flood waters.

The need of tiling out many areas in the county is very definitely shown by the occurrence of small unproductive areas in otherwise rather fertile land. If the soil is too wet, satisfactory crop yields cannot be secured, and the basic treatment needed on such soils is the installation of tile. It may be an expensive operation but the results secured always warrant the outlay. Other fertilizer treatments will be of little value on land which is not properly drained. There is abundance of data to show the benefits from tiling out wet lands. In many instances it means the difference between a crop failure and very satisfactory crop yields. Farmers in Jasper County should see to it that all their land is adequately drained if they wish to secure the best returns.

### THE ROTATION OF CROPS

It is quite generally known that the continuous growing of any one crop will very quickly reduce the fertility of the soil and cut down crop yields. Despite the general knowledge of this fact, however, farmers are still inclined to grow the same crops on the same land year after year, because of the large money value of the crop. They soon find, however, that the yields of the crop are decreasing and sooner or later the growth of the crop will become unprofitable. When a rotation is practiced, the yields do not fall off so rapidly and even if some of the crops included in the rotation have less money value, the total income from all the crops grown over a period of years will be much greater where the rotation is practiced. Evidently to maintain the permanent fertility of the land as well as to secure the largest possible income, crop rotation is absolutely essential.

No definite rotation experiments have been conducted in Jasper County. A number of rotations, however, are being used quite successfully in various parts of the state and the following are given as examples of some of these. No one rotation can be recommended for all conditions but from among those mentioned some one may be chosen which will undoubtedly be suitable for the particular conditions in Jasper County.

#### 1. SIX-YEAR ROTATION

*First year* —Corn.

*Second year*—Corn.

*Third year* —Wheat or oats (with clover, or clover and grass).

*Fourth year*—Clover, or clover and grass.

*Fifth year* —Wheat (with clover), or grass and clover.

*Sixth year* —Clover, or clover and grass.

This rotation may be reduced to a five-year rotation by cutting out either the second or sixth year and to a four-year rotation by omitting the fifth and sixth years.

#### 2. FOUR OR FIVE-YEAR ROTATION

*First year* —Corn.

*Second year*—Corn.

*Third year* —Wheat or oats (with clover or with clover and timothy).

*Fourth year*—Clover (If timothy was seeded with the clover the preceding year, the rotation may be extended to five years. The last crop will consist principally of timothy).

#### 3. FOUR-YEAR ROTATION WITH ALFALFA

*First year* —Corn.

*Second year*—Oats.

*Third year* —Clover.

*Fourth year*—Wheat.

*Fifth year* —Alfalfa (The crop may remain on the land five years. This field should then be used for the four-year rotation outlined above and the alfalfa shifted to one of the fields which previously was in the four-year system).

## 4. FOUR-YEAR ROTATIONS

*First year* —Wheat (with clover).  
*Second year*—Corn.  
*Third year* —Oats (with clover).  
*Fourth year*—Clover.

*First year* —Corn.  
*Second year*—Wheat or oats (with clover).  
*Third year* —Clover.  
*Fourth year*—Wheat (with clover).

*First year* —Wheat (with clover).  
*Second year*—Clover.  
*Third year* —Corn.  
*Fourth year*—Oats (with clover).

## 5. THREE-YEAR ROTATIONS

*First year* —Corn.  
*Second year*—Oats or wheat (with clover seeded in the grain).  
*Third year* —Clover (In grain farming, only the grain and clover seed should be sold; most of the crop residues such as corn stover and straw should be plowed under. The clover may be clipped and left on the land to be returned to the soil and only the seed taken from the second crop).

*First year* —Corn.  
*Second year*—Oats or wheat (with clover).  
*Third year* —Clover.

*First year* —Wheat (with clover).  
*Second year*—Corn.  
*Third year* —Cowpeas or soybeans.

## THE PREVENTION OF EROSION

Erosion is the carrying away of soil thru the free movement of water over the surface of the land. If all the rain falling on the ground were absorbed, erosion could not occur, hence it is evident that the amount and distribution of rainfall, the character of the soil, the topography or the "lay of the land," and the cropping of the soil are factors which determine the occurrence of this injurious action.

There are two types of erosion, sheet washing and gullying. The former may occur over a rather large area and the surface soil may be removed to such a large extent that the subsoil may be exposed and crop growth prevented. Gullying is more striking in appearance but it is less harmful and it is usually more easily controlled. If, however, a rapidly widening gully is allowed to grow unchecked, an entire field may soon be made useless for farming purposes.

Erosion occurs to a considerable extent in some of the areas in Jasper County. The steep phase of the Carrington loam is particularly subject to this destructive action. It occurs also, however, to a considerable extent in the Clinton silt loam, in the Shelby loam, the Lindley loam, the Lindley silt loam and in some areas of the Tama silt loam. Occasionally areas of the Clarion loam and the Carrington loam on the drift uplands are injured to some extent thru a washing away of the surface soil. Serious injurious effects from the washing of the soils often occur in some of the soil types mentioned in this county and it is very important that some means of prevention or control of this destructive action should be adopted. From among the suggestions offered some method may be chosen which will be suitable for application under almost any conditions.

The means which may be employed to control or prevent erosion in Iowa may be considered under five headings as applicable to "dead furrows," to small gullies, to large gullies, to bottoms and to hillside erosion.



## EROSION DUE TO DEAD FURROWS

Dead furrows or back furrows, when running with the slope or at a considerable angle with it, frequently result in the formation of gullies.

*"Plowing in."*—It is quite customary to "plow in" the small gullies that result from these dead furrows and in level areas this process may be quite effective. In the more rolling areas, however, it is best to supplement the "plowing in" with a series of "staked in" dams or earth dams.

*"Staking in."*—The method of staking in is better as it requires less work and there is less danger of washing out. The process consists in driving in several series of stakes across the gully and up the entire hillside at intervals of from 15 to 50 yards, according to the slope. The stakes in each series should be placed three or four inches apart. It is then usually advisable to weave some brush about the stakes, allowing the tops of the brush to point upstream. Additional brush may also be placed above the stakes, with the tops pointing upstream, permitting the water to filter thru, but holding the fine soil.

*Earth Dams.*—Earth dams consist of mounds of soil placed at intervals along the slope. There are some objections to the use of earth dams, but in many cases they may be quite effective in preventing erosion in "dead furrows."

## SMALL GULLIES

Gullies result from the enlargement of surface drainageways and they may occur in cultivated land, on steep hillsides in grass or other vegetation, in the bottomlands, or any place where water runs over the surface of the land. Small gullies may be filled in a number of ways but it is not practicable to fill them by dumping soil into them; that takes much work and is not lasting.

*Checking Overfalls.*—The formation of small gullies or ditches is practically always the result of overfalls. An easy method of checking the overfalls is to put in an obstruction of straw and brush and stake down with a post. One or more posts should be set firmly in the ground in the bottom of the gully. Brush is intertwined between the posts, straw is well tramped down behind them and the straw and brush are held in place by cross pieces nailed to the posts.

*"Staking in."*—The simplest method of controlling small or moderate sized gullies and the one that gives the most general satisfaction is the "staking in" operation recommended for the control of dead furrow gullies.

*The Straw Dam.*—A simple method of preventing erosion in small gullies is to fill them with straw. This may be done at threshing time with some saving of time and labor. The straw is usually piled near the lower part of the gully, but if the gully is rather long or branching, it should be placed near the middle or below the junction of the branches or more than one dam should be used.

*The Earth Dam.*—The use of an earth dam or mound of earth across a gully may be a satisfactory method of controlling erosion under some conditions. In general it may be said that when not provided with a suitable outlet under the dam for surplus water the earth dam cannot be recommended. When such an outlet is provided the dam is called a "Christopher" or "Dickey" dam.

*The "Christopher" or "Dickey" Dam.*—This modification of the earth dam consists merely in laying a line of tile down the gully and beneath the dam, an elbow or a "T," being inserted in the tile just above the dam. This "T," called the surface inlet, usually extends two or three feet above the bottom of the gully. A large sized tile should be used in order to provide for flood waters and the dam should be provided with a cement or board spillway or runoff to prevent any cutting back by the water flowing from the tile. The earth dam should be made somewhat higher and wider than the gully and higher in the center than at the sides to reduce the danger of washing. It is advisable to grow some crop upon it, such as sorghum, or even oats or rye, and later seed it to grass.

*The Adams Dam.*—This dam is practically the same as the Christopher or

Dickey Dam. In fact the principle of construction is identical. In some sections the name "Adams dam" has been applied and hence it is mentioned separately.

*The Stone or Rubble Dam.*—Where stones abound they are frequently used in constructing dams for the control of erosion.

*The Rubbish Dam.*—The use of rubbish in controlling erosion is a method sometimes followed and a great variety of materials may be employed. The results are in the main rather unsatisfactory and it is a very unsightly method.

*The Woven Wire Dam.*—The use of woven wire, especially in connection with brush or rubbish, has sometimes proven satisfactory for the prevention of erosion in small gullies.

*Sod Strips.*—The use of narrow strips of sod along natural surface drainage-ways may often prevent these channels from washing into gullies, as the sod serves to hold the soil in place. Bluegrass is the best crop to use for the sod, but timothy, redtop, clover or alfalfa may serve quite as well and for quick results sorghum may be employed if it is planted thickly.

*The Concrete Dam.*—One of the most effective means of controlling erosion is by the concrete dam, provided the Dickey system is used in connection with it. They are, however, rather expensive. Owing to their high cost and the difficulty involved in securing a correct design and construction, such dams cannot be considered as adapted to general use on the farm.

*Drainage.*—The ready removal of excess water may be accomplished by a system of tile drainage properly installed. This removal of water to a depth of the tile increases the water absorbing power of the soil, and thus decreases the tendency toward erosion.

#### LARGE GULLIES

The erosion in large gullies which are often called ravines may in general be controlled by the same methods as for small gullies. The Dickey dam is the only method that can be recommended for controlling and filling large gullies and it seems to be giving very satisfactory results at the present time.

#### BOTTOMLANDS

Erosion frequently occurs in bottomlands and especially where such lowlying areas are crossed by small streams the land may be very badly cut up and rendered almost entirely valueless for farming purposes.

*Straightening and Tiling.*—The straightening of the larger streams in bottomland areas may be accomplished by any community and while the cost is considerable, large areas of land may thus be reclaimed.

*Trees.*—Erosion is sometimes controlled by rows of such trees as willows which extend up the drainage channels. While the method has some good features it is not generally desirable.

#### HILLSIDE EROSION

Hillside erosion may be controlled by certain methods of soil treatment which are of value, not only in preventing the injurious washing of soils, but in aiding materially in securing satisfactory crop growth.

*Use of Organic Matter.*—Organic matter or humus is the most effective means of increasing the absorbing power of the soil and hence it proves very effective in preventing erosion. Farm manure may be used for this purpose or green manures may be employed if farm manure is not available in sufficient amounts. Crop residues such as straw and cornstalks may also be turned under in soils to increase their organic matter content.

*Growing Crops.*—The growing of crops, such as alfalfa, that remain on the land continuously for a period of two or more years, is often advisable on steep



hillsides. Alsike clover, sweet clover, timothy and red top are also quite desirable for use in such locations.

*Contour discing.*—Discing around a hill instead of up and down the slope or at an angle to it is frequently very effective in preventing erosion. This practice is called "contour discing" and it often has proven quite satisfactory in Iowa.

*Sod Strips.*—The use of narrow strips of sod is very desirable for preventing hillside erosion as well as for the preventing of gully formation. The sod protects the field from the flow of water during rains and prevents the washing away of the surface soil.

*Deep Plowing.*—Deep plowing increases the absorptive power of the soil and hence decreases erosion. It is especially advantageous if it is done in the fall as the soil is then put in condition to absorb and hold the largest possible amount of the late fall and early spring rains.

## INDIVIDUAL SOIL TYPES IN JASPER COUNTY\*

There are 32 individual soil types in Jasper County and these with the steep phase of the Carrington loam and an area of peat and muck, make 34 separate soil areas. These are divided into four large groups according to their origin and location. These groups are known as drift soils, loess soils, terrace soils, and swamp and bottomland soils.

### DRIFT SOILS

There are 11 drift soils in the county and together with the steep phase of the Carrington loam a total of 12 drift soil areas. They are classified in the Carrington, Shelby, Lindley, Clarion, and Webster series. Together they cover 21.9 per cent of the total area of the county.

#### CARRINGTON LOAM (1)

The Carrington loam is the most extensive drift soil in the county and together with the steep phase which is much smaller in extent, it occupies 10.1 per cent of the total area of the county, being the third type in area. It occurs chiefly in the western part of the county, making up a large part of the upland in Clear Creek, western Poweshiek and northwestern Washington Townships. It also occurs in many smaller areas in various parts of the county, being found in narrow irregular strips along the various streams and intermittent drainageways of the county. In these areas it is found in an intermediate position between the loessial upland soils and the bottomland types along the drainageways themselves. In these locations the type is of less importance agriculturally. The largest occurrence of narrow areas along the streams of the county is found along the North Skunk River, north and west of Kellogg.

The surface soil of the Carrington loam is a dark brown mellow loam, extending to a depth of 12 to 14 inches. Below that point the subsoil is a brown to yellowish-brown heavy loam. Below 16 to 20 inches and extending thru the three-foot section, the subsoil is a silty clay to clay loam, yellowish-brown to yellow in color and containing sand, pebbles and rock fragments. Occasionally boulders occur on the surface of the soil or within the three foot section. On the tops of hills and ridges the soil is somewhat lighter in color and frequently contains a larger amount of sand. In the lower positions the color is darker and the texture is more silty. In the narrow areas along the streams and drainageways the soil is apt to be lighter in color.

In topography the Carrington loam is strongly undulating to rolling, being mainly gently rolling. The natural drainage system of the type is quite ade-

\*The description of individual soil types given in this section of the report very closely follow those in the Bureau of Soils report.



Fig. 10. Carrington loam topography, Jasper County.

quate. In some of the lower lying level areas drainage has been poor and the installation of tile has improved conditions for crop growth. Erosion occurs to some extent in the type and the rougher areas are frequently subject to very serious gullying.

Practically all of the Carrington loam is under cultivation. There is a small area in permanent pasture, small woodlots and a very inconsiderable area which is not suitable for cropping. General farm crops are grown on the type. Corn yields 35 to 50 bushels per acre; oats, 35 to 45 bushels; and clover and timothy hay, 1 to 2 tons per acre.

Yields of general farm crops on the Carrington loam are ordinarily quite satisfactory but large increases are secured thru proper treatment. The application of farm manure has been found very beneficial on this type and large increases in the yields of all general farm crops have been secured. The type is acid in reaction and the application of lime is very desirable for the best growth of legumes. Large increases in yields of other farm crops also follow the application of lime. The type is not well supplied with phosphorus and the use of a phosphate fertilizer would be very desirable. Experiments discussed earlier in this report have indicated a large value from the use of a phosphate fertilizer on this type. Acid phosphate sometimes gives better results than rock phosphate but in other cases the rock phosphate seems quite as satisfactory. The relative value of the two cannot therefore be definitely stated at present. Tests on individual soil types are recommended. It seems certain that the soil will respond to one or the other of the phosphate fertilizers. In a few areas there is need for drainage and installation of tile would be very desirable. On some of the more rolling areas erosion occurs to a considerable extent and it is very important that some method be taken to prevent the washing away of the surface soil and the formation of gullies. In a few of the roughest areas the type should undoubtedly be kept in grass to prevent erosion from occurring.

#### CARRINGTON LOAM, STEEP PHASE (57)

The steep phase Carrington loam is a minor type in the county, covering, however, over two per cent of the total area. It is developed in small areas in practically all parts of the county, occurring on the lower slopes to the drainage-



ways thru the loessial uplands. One area occurs in Clear Creek Township in the drift upland area. The largest development of the type is found in Rock Creek Township, in Hickory Grove Township and in Mariposa and Buena Vista Townships. Numerous small areas of the phase occur in other parts of the county.

The surface soil of the steep phase of the Carrington loam is shallower than the typical soil and usually not over 6 to 8 inches in depth. It is often much lighter colored than the typical Carrington loam. This is particularly true on the high points where the surface soil is thinner. The subsoil contains sand, gravel and boulders and is more loose and porous than the subsoil of the typical Carrington. In many areas of the phase, however, the soil is very much like the typical Carrington except that it is shallower at the surface. Within areas of the phase there are included small spots of the typical soil which are too small to show on the map.

As the name indicates, the topography of the phase is steep to abrupt and the soil is not important agriculturally. Forest growths occur on most of it and it is utilized for pasture purposes. Very little is under cultivation. It is subject to serious erosion and the washing of the soil is very difficult to control if the land is cultivated.

The chief need of the phase is for protection from erosion. On the cultivated areas, applications of farm manure in liberal amounts would be of large value. The turning under of leguminous crops as green manures would also improve the soil conditions as well as reduce the danger of erosion. The type is acid and in need of lime and applications of phosphate fertilizers would undoubtedly prove of value.

#### SHELBY LOAM (79)

The Shelby loam is the second largest drift soil in the county and the fifth type. It occupies 7.0 per cent of the total area. It occurs in numerous areas in all parts of the county, being found in narrow irregular strips along the various streams, tributaries and intermittent drainageways extending thruout the loessial upland. It occurs on the lower slopes of the drainageways separating the uplands from the narrow areas of bottomland soils or from the streams and drainageways themselves. There are a few small areas of the type in the north-western part of the county in the drift upland. The largest development of the Shelby loam is found in the eastern and north central townships.

The surface soil of the Shelby loam is a dark brown loam, extending to a depth of 8 to 10 inches. The upper subsoil, to a depth of 20 inches, is a yellowish-brown to yellow gravelly, sandy clay loam or clay containing layers of gravel. The lower subsoil is a reddish-brown sandy clay loam, containing considerable sand or gravel. In some places the surface soil shows a high content of sand but the typical texture is a loam. Occasionally the subsoil is made up mainly of gravel, sand and rock with some admixture of clay. Boulders occur on the surface of the type and thruout the soil section. In a few local areas there is some calcareous material in the subsoil. These are very small and relatively unimportant areas.

In topography the Shelby loam ranges from gently rolling to strongly rolling or broken. The natural drainage of the type is quite adequate. On some of the steeper areas and in those areas where there is a large amount of gravel in the subsoil, drainage is excessive and crops suffer during periods of drought. The type is subject to erosion and there is extensive gully formation.

The major portion of the type is under cultivation. In some of the rougher areas where the land is steep in topography the type is preferably left in pasture. There is some timber growth on many of the rougher sections. On the cultivated areas corn, oats and hay crops are grown. Corn yields 20 to 40 bushels per acre; oats, 20 to 35 bushels; and clover and timothy, 1 to 1½ tons per acre.

On the cultivated areas of the Shelby loam, applications of farm manure would be of very large value in increasing the yields of general farm crops. Liberal amounts of this material should be employed. It has an additional value by reducing the danger of erosion on the soil. Where farm manure is not available, the turning under of leguminous crops as green manures would be of very considerable value. The type is acid in reaction and applications of lime are necessary, especially for the best growth of legumes. The type will also respond in a very large way to applications of phosphate fertilizers and tests of acid phosphate are recommended.

#### LINDLEY LOAM (65)

The Lindley loam is the fourth largest drift soil in the county and the eighth type in area. It covers 1.9 per cent of the total area. It occurs in numerous small, narrow, irregular shaped areas in practically all parts of the county. It is found in much the same position as the Shelby loam, occurring on the lower slopes along the drainageways separating the loessial uplands from the bottom-land types or from the intermittent drainageways. There is one large area of the type in Clear Creek Township in the drift uplands, occurring southwest of Clyde. Another area somewhat smaller in extent occurs in the same township extending to the county line north of Clyde. Besides these two more extensive developments of the type, it occurs in rather extensive narrow areas in Hickory Grove, Mariposa, Kellogg and Lynn Grove Townships.

The surface soil of the Lindley loam is a yellowish-brown loam, extending to a depth of 6 to 8 inches. The subsoil is a yellow sandy gravelly clay, mottled with gray and brown and stained reddish from iron. The surface soil varies from a silt loam to a sandy loam. In various localities these variations are of small extent and could not be shown on the map. In the rougher areas where erosion has occurred to a large extent, the yellowish clay subsoil is exposed on the steep slopes and hill tops. In some areas the subsoil is a gritty clay with mottlings of bluish-drab and ashy gray.

In the area of Lindley loam mapped in the center of Clear Creek Township, southwest of Clyde, the soil is a variation from the typical. In this area the surface soil is a rather ashy gray silty loam which is floury when dry. The surface soil extends to a depth of about 12 inches. The subsoil is a brown to yellowish-brown silty clay to clay loam often mottled with brown, yellow and iron stains. Some sand and fragments of rock occur in the subsoil. In topography the Lindley loam varies from rolling to steep or broken. Drainage is good to excessive. The rougher areas are badly washed and erosion has occurred to a large extent. Much of the surface soil has been washed away and large gullies frequently occur.

Very little of the typical Lindley loam is under cultivation. The steep topography makes the type unsuitable for cultivation and practically all of it is in forest or native grasses. Its best use is undoubtedly for pasture land or timber growth. Even when not cultivated, serious erosion occurs. A part of the gray variation found in Clear Creek Township is under cultivation but most of the area is in pasture and forest.

The chief need of this type when it is cultivated is for protection from erosion. It would also respond to liberal applications of farm manure and the turning under of leguminous crops for green manures. It is acid and would be benefited by additions of lime and the use of a phosphate fertilizer would undoubtedly be of large value.

#### CARRINGTON FINE SANDY LOAM (4)

The Carrington fine sandy loam is a minor type in the county, covering only 1.2 per cent of the total area. It occurs entirely in the northwestern part of the



county in Clear Creek and Poweshiek Townships. All the areas are in the drift sections of the county and lie north of the Skunk River except for one small area in the northern part of Section 5 of Mound Prairie Township and two small areas just south of Colfax. The largest areas of the type are developed in the vicinity of Clyde, north and northwest of Valeria, northwest of Colfax and along Silver Creek in the northwestern corner of Clear Creek Township.

The surface soil of the Carrington fine sandy loam is a dark brown to dark grayish-brown friable fine sandy loam, extending to a depth of 12 to 15 inches. The subsoil is somewhat variable but usually consists of a brown fine sandy loam in the upper part, changing to a yellowish-brown to yellow loam, heavy loam or sandy clay in the lower part of the three-foot section. In some places the subsoil is a sandy loam to loamy fine sand or sand. Gravel and boulders are quite commonly found thruout the three-foot section and also on the surface of the type. In some places the soil has a brown to grayish-brown color. Occasionally small bodies of loamy fine sand, fine sand or a very light textured fine sandy loam are included. These areas are not large enough to be shown on the map.

In topography the Carrington fine sandy loam is rolling to strongly rolling or even broken. Drainage is adequate and in fact is apt to be excessive. In some areas crops suffer in dry seasons. The type is subject to erosion and considerable washing occurs.

In a few areas along the streams there is a growth of timber but practically all of the Carrington fine sandy loam is cultivated. Only a small proportion is in timber growth and permanent pasture. The chief crops grown are corn, oats and hay. Corn yields around 25 to 35 bushels per acre, and oats 25 to 30 bushels per acre in favorable seasons.

On the cultivated areas of this type, applications of farm manure in liberal amounts would be of very large value in increasing crop yields. The incorporation of organic matter would also reduce the danger of crops suffering from drought. Where farm manure is not available for use, the turning under of leguminous crops as green manure would be of large value. The type is acid in reaction and would respond to liming. The use of a phosphate fertilizer would undoubtedly be of large value. Tests of acid phosphate are recommended on this soil.

#### CARRINGTON FINE SAND (86)

The Carrington fine sand occurs entirely in the northwestern and western central part of the county. Numerous small areas of the type are scattered thru the western townships. The largest development is found south of Colfax in Washington Township. Other extensive developments occur north and west of Colfax.

The surface soil of the Carrington fine sand is an incoherent, brown fine sand, extending to a depth of 10 to 12 inches. The subsoil to a depth of 24 inches is a lighter brown fine sand and from 24 to 36 inches is a yellow incoherent fine sand. In some cases there is a small amount of fine gravel distributed thruout the three-foot section. Occasionally the surface soil is more of a loamy fine sand and sometimes it has a yellowish-brown or gray color. In topography the type ranges from undulating to broken.

Most of the Carrington fine sand is in pasture or under cultivation. A few areas support a forest growth. Corn, oats and hay are the chief crops grown on the cultivated areas. Some winter wheat is produced also. Near Colfax the type is used for the growing of melons.

This soil is chiefly in need of organic matter to make it more satisfactorily productive. The liberal application of farm manure would be of very large value. The turning under of leguminous crops as green manures would improve the crop yields greatly. The type is acid and would respond to additions of

lime. It is low in phosphorus fertilizers and the application of acid phosphate would undoubtedly prove of value. Tests of this material are recommended. Where truck crops are to be grown, the use of a special complete commercial fertilizer might prove of large value.

#### CLARION LOAM (138)

The Clarion loam is a minor type in the county, covering only 0.3 per cent of the total area. It is developed practically entirely in Clear Creek Township. A few small areas occur in Sections 18 and 19 of Poweshiek Township and in Section 9 of Washington Township. The largest area is developed along Wolf Creek northwest of Clyde. Another considerable area is along Silver Creek in the northwestern section of the township.

The surface soil of the Clarion loam is a dark brown friable loam, extending to a depth of 12 inches. The subsoil is a brown to yellowish-brown or yellow heavy loam, changing into a yellowish silty clay at about 24 inches. Below this point there is some sand and gravel and a considerable amount of calcareous material. Boulders of varying sizes occur on the surface of the soil and thru the soil section.

In topography the Clarion loam is gently rolling to rolling. On the ridges and tops of the hills the surface soil may be somewhat lighter than the typical Clarion and shallower in depth. On the lower slopes of the hills, the surface soil is deeper and darker. Drainage is quite adequate. Erosion occurs to some extent, particularly on the more rolling areas.

Practically all of the Clarion loam is under cultivation and general farm crops are grown. The yields are very much the same as those secured on the Carrington loam. Increases may be secured thru the same methods of treatment which have been recommended for the Carrington loam. The liberal application of farm manure would be of particular value. The turning under of leguminous crops as green manures would also help. While there is lime present in the subsoil of the type, the surface soil is generally acid in reaction and the application of lime would be very desirable for the best growth of legumes. The type would undoubtedly respond also to the application of a phosphate fertilizer and tests of acid phosphate and rock phosphate are recommended.

#### CLARION FINE SANDY LOAM (149)

The Clarion fine sandy loam is a very minor type in the county, covering only 0.2 per cent of the total area. It occurs entirely in the northwestern townships, several small areas being developed in Poweshiek and Clear Creek Townships. The largest area lies just north of Oswald. A smaller area occurs in Clear Creek Township northwest of Clyde.

The surface soil of the Clarion fine sandy loam is a brown to dark brown fine sandy loam, extending to a depth of 10 to 14 inches. Below this point it grades into a yellowish-brown to yellow sandy loam to sandy clay. The lower subsoil is usually a heavy loam to sandy clay loam. Below 24 to 30 inches there is a considerable accumulation of calcareous material. Gravel occurs thruout the three-foot section and boulders are occasionally found on the surface and thru the section. Within the type there are included small spots of sandy soils which were not large enough to separate on the map.

In topography the Clarion fine sandy loam is gently rolling to rolling or broken. Natural drainage is good but generally not excessive. A small part of the type is in forest growth. It is used partly, however, for cultivated crops, only a small portion being in pasture.

Yields of general farm crops grown on the Clarion fine sandy loam are very much the same as those secured on the Carrington fine sandy loam. The same treatments which were recommended for the Carrington fine sandy loam will



prove of large value on this type—liberal application of farm manure, turning under leguminous green manure crops and the application of lime to correct the acidity in the surface soil. The application of a phosphate fertilizer would undoubtedly be of value and tests with acid phosphate are urged.

#### WEBSTER LOAM (55)

The Webster loam is a minor type in the county, covering only 0.2 per cent of the total area. It occurs entirely in Clear Creek and Poweshiek Townships in the northwestern part of the county. Numerous small areas of the type occur, the largest individual area being in Section 5 of Clear Creek Township.

The surface soil of the Webster loam is a very dark brown to black mellow loam extending to a depth of 10 to 12 inches. Below this is found a layer of black silty clay to clay loam. It is heavier in texture and dark drab in color. It extends to a depth of 18 inches. The subsoil below this point is a drab to yellowish-drab clay loam to clay, becoming somewhat lighter in color in the lower subsoil and mottled with gray, brown and yellow. The lower subsoil contains some sand and occasionally considerable amounts of calcareous material.

In topography the Webster loam is flat to gently undulating. It occurs in flat divides or smooth areas at the heads of drainageways. In most areas the natural drainage is inadequate and the installation of tile is very desirable for the successful growth of crops.

The Webster loam is all under cultivation. Corn, oats and hay are the chief crops grown. Corn yields 50 to 60 bushels per acre, oats 45 to 60 bushels and clover and timothy hay 2 tons per acre.

In many cases the first treatment this soil needs to make it more satisfactorily productive is the installation of tile. When drainage is accomplished, large crop yields are ordinarily secured. The application of small amounts of farm manure would be of value when the type is newly drained. Large amounts of manure should not be employed preceding the small grain crop in the rotation, however, owing to the danger of causing it to lodge. If the surface soil of the type is acid, as is usually the case, small applications of lime might be very desirable for the best growth of legumes. The type will respond to the application of a phosphate fertilizer and tests of acid phosphate or rock phosphate are recommended. Undoubtedly one or the other of these phosphate fertilizers would bring about considerable increases in crop yields.

#### LINDLEY SILT LOAM (32)

The Lindley silt loam is a minor type in the county, covering only 0.1 per cent of the total area. It occurs entirely in Lynn Grove Township in several narrow, irregular-shaped areas, along the streams in the southern part of that township. It is found on the lower slopes along the drainageways.

The surface soil of the Lindley silt loam is a grayish-yellow or grayish-brown silt loam extending to a depth of 8 inches. The subsoil is a yellow or brown heavy silt loam to silty clay loam, grading at 24 inches into a mottled gray, brown, yellow and reddish-brown sandy gravelly clay, stained with iron stains. In topography the type is generally rather strongly rolling.

The Lindley silt loam is largely in pasture, supporting only a little forest growth. It is unimportant agriculturally in the county because of its small extent. When cultivated the type will respond to liberal applications of farm manure or the turning under of leguminous crops as green manures. It is acid in reaction and should be limed for the best growth of legumes. It would undoubtedly respond also to applications of a phosphate fertilizer. Tests with acid phosphate would be very desirable.

## WEBSTER CLAY LOAM (56)

The Webster clay loam is a minor type in the county, covering only 0.1 per cent of the total area. It occurs in several small areas in Washington and Clear Creek Townships on the Polk County line or adjacent to the line.

The surface soil of the Webster clay loam is a black to nearly black clay loam extending to a depth of about 15 inches. The subsoil is a heavy clay loam to clay, dark drab in color, becoming lighter in color and heavier in texture at the lower depths. The lower subsoil is highly calcareous and frequently the calcareous material extends thruout the soil section. In topography the type is level to flat and it occurs usually in slight depressions in the uplands. Drainage is very poorly established.

Most of the type is under cultivation. The first treatment needed to make crop growth more satisfactory is the installation of tile and the thoro drainage of the soil. When this is accomplished, large crop yields may be secured. Yields are very much the same, under favorable conditions, as those secured on the Webster loam. When newly drained, small applications of farm manure would be of value. The material should not be applied preceding the growing of a small grain crop, however. If the surface soil is acid the use of lime would be of value for the best early growth of legumes. The type will undoubtedly respond in a very large way to applications of a phosphate fertilizer. Tests of acid phosphate and rock phosphate on this soil are strongly recommended.

## WEBSTER SILTY CLAY LOAM (107)

The Webster silty clay loam is a very minor type in the county, covering only 0.1 per cent of the total area. It is confined to the northwestern townships and there are numerous small areas scattered thruout the drift uplands, north of the Skunk River in Poweshiek and Clear Creek Townships.

The surface soil of the Webster silty clay loam is a black or nearly black silty clay loam, extending to a depth of 14 to 36 inches. The subsoil below 14 inches is a black to drab clay loam to clay, becoming somewhat heavier in texture and lighter in color at the lower depth. There is a large content of calcareous material in the lower subsoil and frequently the calcareous material extends thruout the three-foot section.

In topography the Webster silty clay loam is flat to gently sloping. It occurs in depressions in the uplands, mainly in narrow strips along intermittent drainageways.

The Webster silty clay loam is unimportant agriculturally in the county, mainly due to its small extent. It is largely under cultivation and general farm crops are grown. The chief need of the type when cultivated is for more adequate drainage and the installation of tile would be of very large value. When thoro drainage is accomplished, crop yields are quite satisfactory. Small applications of farm manure would be of value on newly drained land of this type. Large amounts should not be employed and the manure should not be applied preceding the growing of a small grain crop. The type is usually highly calcareous and not in need of lime. If the surface soil is acid, however, and legumes are to be grown, it might be desirable to make a small application of lime in spite of the high content in the lower soil layers. The application of a phosphate fertilizer would undoubtedly be of value and tests of acid phosphate and rock phosphate are recommended.

## LOESS SOILS

There are six loess soils in the county, classified in the Tama, Clinton, Muscatine, Grundy, Knox and Marion series. Together they cover 62.5 percent of the total area of the county.



## TAMA SILT LOAM (120)

The Tama silt loam is the largest loess soil in the county and the most extensive individual type. It covers 42.3 percent of the total area. It is developed in extensive areas on the uplands in all parts of the county except in western Clear Creek and Poweshiek Townships and in northern Washington Township. The largest continuous areas of the type are found in Des Moines and western Fairview Townships. It occurs in association with the other upland types such as the Muscatine, Grundy and Clinton silt loams on the loessial uplands and the Carrington, Shelby and Lindley types on the glacial uplands. In parts of the county it occurs in narrow, irregular-shaped areas along the divides between the drainageways or surrounding irregular-shaped bodies of the Muscatine or Grundy silt loam.

The surface soil of the Tama silt loam is very dark brown smooth silt loam, extending to a depth of 14 inches. The subsoil is a brown to yellowish-brown or yellow compact heavy silt loam to silty clay loam. There is a gradual transition in color and texture from 14 to 36 inches, the subsoil being heavier in texture and lighter in color at the lower depths. In the large areas, the type is quite uniform in color and texture, the only variation being that on the crests of hills or narrow ridges the surface soil is only 8 to 10 inches in depth. In some places at the base of slopes along intermittent drainageways, the surface soil is darker in color than typical and sometimes it is mottled with brown and yellow. Where the type occurs adjacent to the Muscatine silt loam, the surface soil is somewhat steeper than typical and there is some mottling in the lower subsoil. Apparently there is a transition from the Tama silt loam into the Muscatine and the establishment of the boundary line between the two is often made rather arbitrarily. In places there are gradual changes also from the Tama silt loam into the Clinton silt loam and again the boundaries are frequently arbitrarily located.

The chief variation from the typical Tama silt loam consists of the presence of considerable calcareous materials in the form of nodules or concretions within the three-foot section. This variation occurs thruout all of the type mapped in Washington Township except that in Sections 25, 29, 31 to 36, inclusive, and in the southern parts of Sections 26 and 30. Another area of the variation occurs in the southeastern part of Palo Alto Township. Several small areas occur on the line between Sections 21 and 22, Palo Alto Township, and in Section 14, Poweshiek Township and in Section 30, Independence Township. The lime concretions vary considerably in size and are generally found in the subsoil altho sometimes they occur within the surface soil.

In topography the Tama silt loam is undulating to gently rolling or rolling. Where it occurs adjacent to the Clinton silt loam the topography is a little more strongly rolling. The natural drainage of the type is good except in some small areas along intermittent drainageways.

Practically all of the type is under cultivation. Only a small proportion is used for permanent pasture. General farm crops are grown including corn, oats and hay. Corn yields 45 to 60 bushels per acre, oats yield 40 to 50 bushels per acre. Some wheat is grown, yielding 18 to 26 bushels per acre. Clover yields  $1\frac{1}{2}$  to 2 tons per acre.

Crop yields are generally quite satisfactory on the Tama silt loam but increases in yields are often secured thru proper methods of soil treatment. Liberal applications of farm manure have been found to bring about large increases in the yields of general farm crops on this type. The turning under of leguminous crops as green manures would also often prove of value. The type is acid in reaction and liberal amounts of lime should be used according to the needs as indicated by tests of the surface soil. The application of a phosphate fertilizer would also undoubtedly prove of value. Tests which have been carried out on



Fig. 11. Tama silt loam topography, Jasper County.

fields of this type have indicated very large returns from the application of these fertilizing materials. Whether acid phosphate or rock phosphate should be employed has not yet been definitely determined, and it is recommended that farmers test the relative effect of acid phosphate and rock phosphate under their own conditions to learn which material will prove the more profitable. In small areas the type may not be adequately drained and in such places the installation of tile is very necessary for the best growth of crops. In the more rolling to steeply rolling areas some erosion has occurred and in these places the protection of the land from serious washing is important.

#### CLINTON SILT LOAM (80)

The Clinton silt loam is the second largest loess soil and the second largest type in the county, covering 12.8 percent of the total area. It occurs in numerous areas in all parts of the county except the northwestern corner, in association with the other loessial upland types and adjacent to some of the drift areas. The largest developments of the type are found in Hickory Grove and Rock Creek Townships, along Rock Creek and Sugar Creek and in Sherman and Independence Townships along Prairie Creek and some of the other creeks flowing into the Skunk River. It is developed mainly along the Skunk River and its tributaries, along Rock Creek, Sugar Creek, Elk Creek and Indian Creek and the various tributaries to these streams. Numerous small isolated areas occur along intermittent drainageways in various parts of the county.

The surface soil of the Clinton silt loam is a brown to yellowish-brown or grayish-brown mellow silt loam, extending to a depth of 7 to 10 inches. The subsoil is a brownish-yellow to yellow heavy compact silt loam to silty clay, becoming lighter in color and somewhat heavier in texture at the lower depths. There are markings with light gray and faint mottlings of brown in the lower subsoil. In the rougher, more eroded areas, the ridges and hills are covered with a very light colored surface soil, while at the base of the hills, the soil is darker and deeper. In forested areas the upper 2 or 3 inches of the surface soil sometimes has a darker brown color. In some areas the soil has a grayish cast and approaches a Marion silt loam in appearance. In places the boundary between



this type and the Tama silt loam has been very difficult to establish owing to a gradual gradation from one type to the other.

In topography the Clinton silt loam is generally strongly rolling to rough or broken. In some areas along the larger streams the surface is a succession of sharp hills and steep valleys, 75 to 150 feet above the bottomland. Drainage is good to excessive. Erosion is active and considerable washing of the soil has occurred.

Much of the Clinton silt loam was originally in forest growth consisting largely of oak, hickory, hazel brush, elm, maple, willow, elder and butternut. Some of the cleared land is now in pasture. A large portion of the type is under cultivation, corn, oats and hay being the chief crops grown. Corn yields 20 to 50 bushels per acre, oats 20 to 45 bushels, and hay 1 to 2 tons per acre.

In the western part of the county there is a variation of the soil which is highly calcareous. If there had been a sufficiently large area, this variation would have been mapped as Knox silt loam. In this area, the surface soil to a depth of 6 to 8 inches is a brown to yellowish-brown silt loam, mellow and friable. The subsoil is a yellowish-brown friable, heavy silt to silty clay, extending to a depth of 24 inches where it changes into a yellow friable heavy silt loam containing much very fine sand. Lime occurs in the form of concretions throughout the subsoil and sometimes within the surface soil. Most of the areas of this variation are found in the western two-fifths of the county, but there are a few areas in the uplands along the bottoms of the Skunk River. There is an area one and a half miles south of Galesburg adjacent to the bottomland, which is the farthest east that the variation is found. In topography this variation from the typical soil is strongly rolling to broken. Very little of the land is forested, most of it being in pasture or under cultivation. Some of the rougher areas are not suitable for cultivation and should be kept in grass.

The needs of the typical Clinton silt loam to make it more productive include the application of farm manure, the addition of lime and treatment with a phosphate fertilizer. Liberal amounts of manure should be applied to the soil and large increases in crop yields are secured from the application of this material. The turning under of leguminous crops as green manures would be of very large value in increasing the productivity of the soil. The type is acid in reaction and applications of lime are very necessary for the best growth of all farm crops and particularly of legumes. The application of a phosphate fertilizer would prove of large value on the type and tests of acid phosphate are recommended. Experiments which have been carried out on this soil have indicated the value of farm manure, of lime and of a phosphate fertilizer. Whether acid phosphate or rock phosphate should be employed cannot yet be definitely stated but the indications are that acid phosphate probably is of somewhat larger value than rock phosphate. The two materials might yield different effects under varying conditions. The soil is particularly in need of protection from erosion if cultivated crops are to be successfully grown. From the suggestions given earlier in this report, some method may be chosen to control or prevent the destructive washing away of the surface soil and the formation of gullies. Land which is badly gullied may be reclaimed thru the proper use of methods which have been mentioned.

#### MUSCATINE SILT LOAM (30)

The Muscatine silt loam is a minor type in the county and the third largest loess soil. It covers 5.6 per cent of the total area. It occurs in many areas in all parts of the county except the northwestern corner, occupying the flat, level or slightly undulating divides in the uplands. It is usually associated with the rolling Tama silt loam but in a few areas it is adjacent to the more strongly rolling Clinton silt loam. The most extensive areas of the Muscatine silt loam are near Newburg, north and east of Baxter, from Prairie City to Monroe, north

and east of Newton, south and southwest of Kellogg, near Killduff and in Rock Creek Township. There are many small areas from 10 to 100 acres in size scattered thruout the upland.

The surface soil of the Muscatine silt loam is a very dark brown to nearly black silt loam extending to a depth of 17 inches. The upper subsoil to a depth of 24 inches is a dark brown heavy silt loam to silty clay loam, mottled with yellowish-brown and stained with iron. Below 24 inches the subsoil is a silty clay loam, heavier in texture and lighter in color at the lower depths. The lower subsoil is distinctly mottled with yellow, brown and gray. In some areas where the type is adjacent to the Clinton silt loam on the rougher land, the surface soil is a little lighter in color and shallower in depth. Where the type occurs adjacent to the Grundy silt loam the color of the surface soil is more of a gray. The subsoil is heavier and more tenacious. In many cases the establishment of boundary lines between the Muscatine and Grundy are made rather arbitrarily, as there is a gradual transition from the one type to the other.

Practically all of the Muscatine silt loam is under cultivation, corn, oats, and hay being the chief crops grown. Corn yields 50 to 65 bushels per acre on the average; oats, 50 to 55 bushels; and clover, 2 to 3 tons of hay per acre. The yields of crops vary considerably, depending on the season and the particular conditions of the soil. Corn yields sometimes are as high as 70 to 80 bushels and in some cases may run considerably below the average. In general, however, the yields on the Muscatine silt loam are very satisfactory.

Considerable increases in the yields of general farm crops may be secured on this soil thru proper methods of treatment. Applications of farm manure are of considerable value as has been indicated in the experiments discussed earlier in this report. Even tho the type is high in organic matter and black in color, additions of farm manure increase its fertility. The type is acid in reaction and the application of lime is of large value, particularly for the growth of legumes. It will undoubtedly respond to applications of phosphate fertilizers as has been indicated by experimental work. Whether rock phosphate or acid phosphate should be employed has not yet been definitely determined. The results have indicated large value, however, from both materials and tests on individual farms are recommended. In a few cases the type will be benefited by the laying of tile as the drainage conditions are not always entirely satisfactory.

#### GRUNDY SILT LOAM (64)

The Grundy silt loam is a minor type in the county, covering only 0.9 per cent of the total area. It occurs entirely in the southeast corner of the county in a considerable area extending diagonally across Lynn Grove Township and beyond the township line toward Killduff. Several small isolated areas of the type are also found in the same township on the flat upland divides.

The surface soil of the Grundy silt loam is a dark grayish-brown to nearly black smooth silt loam extending to a depth of about 17 inches. The upper subsoil to a depth of 24 inches is a heavy silt loam to silty clay loam, dark drab in color. The lower subsoil below 24 inches is a heavy tenacious clay loam to clay, mottled with gray, brown and yellow. The entire subsoil has more of a grayish cast than is true of the Muscatine silt loam. Within the type there are shallow depressions where the surface soil is a black silty clay loam and the subsoil is a heavy drab-colored tenacious clay. These areas are too small to separate on the map. Where the type occurs adjacent to the Muscatine silt loam, southeast of Killduff, there is a gradual transition from the one type to the other and the boundary lines are established rather arbitrarily.

In topography the Grundy silt loam is level to flat, varying to undulating or slightly rolling on the edges of the areas adjacent to the Tama silt loam.

Practically all of the type is under cultivation, corn, oats and hay being the



chief crops grown. Corn yields 55 to 65 bushels per acre; oats, 45 to 60 bushels and clover hay, 2 to 3 tons per acre. Crop yields are generally quite satisfactory on this soil.

The treatments recommended for the Muscatine silt loam apply equally well to the Grundy silt loam. Applications of farm manure are of large value on the soil as has been indicated by field experiments on the type in many fields in southern Iowa and by much farm experience. Liberal applications of farm manure on this soil are very desirable. The type is acid in reaction and would respond to applications of lime. It would also prove profitable to apply a phosphate fertilizer on this soil. The relative effects of acid phosphate and rock phosphate have been tested in the field experiments which are under way on this soil and in some cases acid phosphate has proven preferable but in other cases rock phosphate has seemed to be quite as desirable for use. Tests of the two phosphates on individual farms are therefore recommended.

#### KNOX FINE SAND (33)

The Knox fine sand is a minor type in the county, covering 0.7 per cent of the total area. It occurs in a number of areas on the bluffs on the east side of the Skunk River bottomlands from about two miles south and a little west of Ira to the Marion County line. The areas are long and irregular in shape, extending along the uplands for distances varying from one-fourth of a mile to one mile in width. The largest areas of the type are south of Reasnor in Section 32 and 33 of Elk Creek Township and north and west of Metz.

The surface soil of the Knox fine sand is a yellowish-brown to yellow fine sand, extending to a depth of 6 inches. The subsoil is an incoherent yellow fine sand. In some areas the surface soil is more of a brown than a yellowish-brown in color. In other places where there has been shifting by the wind, the surface is a yellow, light yellow, or cream color. Occasionally lime concretions are found in the subsoil.

In topography the type is gently rolling to strongly rolling or broken. Drainage is thoro to excessive and crops are apt to suffer from drouth. There is some washing of the soil on the rougher areas.

A large part of the Knox fine sand is under cultivation. A small area is forested but the major portion is utilized for the growing of general farm crops and truck crops. Corn yields 15 to 30 bushels per acre; oats and rye, 15 to 25 bushels; and hay,  $\frac{1}{2}$  to  $1\frac{1}{2}$  tons per acre. Watermelons and cantaloupes are grown successfully on this soil, particularly in the vicinity of Colfax. Much of the type is in pasture.

Crop production on the Knox fine sand will be improved considerably by the application of farm manure and the turning under of leguminous crops for green manures. The soil is chiefly in need of more organic matter to make it more retentive of moisture and generally more highly productive. It is apt to be acid in reaction in the surface soil and if legumes are to be grown, applications of lime would be of value in spite of the fact that lime occasionally occurs in the subsoil. The addition of a phosphate fertilizer would undoubtedly prove of value also in growing general farm crops. Tests of acid phosphate are recommended. Where truck crops are to be grown, the application of a complete commercial fertilizer might be of value. A brand should be selected which is particularly designed for the growth of truck crops.

#### MARION SILT LOAM (67)

The Marion silt loam is a minor type in the county, covering only 0.2 per cent of the total area. It occurs entirely in the northwestern part of the county in several small areas. The largest development of the type is in Section 7 of In-

dependence Township and in Sections 24 and 25 of Clear Creek Township, extending over into the adjacent sections of Independence Township.

The surface soil of the Marion silt loam is a light grayish-brown silt loam, extending to a depth of 6 inches. Below this point there is a subsurface layer of a light gray floury or ashy silt loam, to a depth of 8 to 15 inches. The subsoil is a brown to yellowish-brown or yellow silty clay loam to clay loam, becoming heavier at the lower depths. The lower subsoil is generally mottled with yellow and brown and stained with iron. In some areas such as that in Section 25 of Clear Creek Township, the surface soil is dark gray to brownish-gray when wet but becomes ashy gray when dry. The subsoil is a grayish-brown to light brown heavy silt loam to silty clay. In forested areas slight accumulations of organic matter occur and the surface soil is a little darker in color for a depth of 2 or 3 inches. Where the type adjoins the Tama or Clinton silt loam, the transition from one soil to the other is gradual and the boundary lines between the types have been placed rather arbitrarily.

In topography the Marion silt loam is strongly rolling to broken. The area in Section 25 of Clear Creek Township has a gently rolling topography. Drainage is good to excessive.

Much of the type is still in timber growth. Some areas, however, have been cleared and are under cultivation. Corn, small grains and hay are the chief crops grown. The yields are somewhat lower than those secured on the Clinton silt loam.

The chief need of the type when it is cultivated is for additions of organic matter. Liberal amounts of farm manure should be applied and large increases in crop yields will result from the application. The turning under of leguminous crops as green manures would also be of very large value on this soil. The type is acid in reaction and would respond to applications of lime. It would also prove profitable to apply a phosphate fertilizer and tests of acid phosphate are recommended.

### TERRACE SOILS

There are nine terrace types in the county, classified in the Bremer, Waukesha, Buckner, O'Neill and Chariton series. Together they cover 1.9 percent of the total area.

#### BREMER SILT LOAM (88)

The Bremer silt loam is the most extensive terrace soil. It is small in area, however, covering only 0.4 per cent of the county. It occurs in a number of small areas on the terraces along the Skunk River, the North Skunk River, Indian Creek and many other of the smaller creeks of the county. There are no very extensive areas of the type, the largest developments being found north of Colfax and southeast of Galesburg, extending to the Marion County line.

The surface soil of the Bremer silt loam is a very dark brown to black or nearly black silt loam, extending to a depth of 16 inches. The upper subsoil is a dark drab to drab clay loam or silty clay loam to a depth of 24 inches, being somewhat lighter in color and heavier in texture at the lower depths. The lower subsoil below 24 inches is a drab to gray heavy clay loam to clay, lighter in color and heavier in texture in the lower parts of the soil section. In some places the subsoil is mottled with brown and yellow. The gray color usually predominates. Within the type are included small areas of silty clay loam too small to separate on the map. These are found in depressed areas. In some places the surface soil has a loam texture, but these areas are likewise too small to show on the map. Where the type occurs adjacent to the Wabash silt loam on the bottoms, the transition from the one type to the other is gradual and the boundary lines are established rather arbitrarily.





Fig. 12. A typical farmstead, Jasper County.

In topography the Bremer silt loam is flat to depressed, usually, however, sloping gently to the adjacent first bottoms. The natural drainage of the soil is fair but in many of the flat areas the installation of tile would be very desirable to remove excess moisture.

The type is practically all under cultivation and utilized for general farm crops. Corn yields 40 to 60 bushels per acre; oats, 35 to 55 bushels; and hay,  $1\frac{1}{2}$  to 2 tons per acre.

Crop yields on the Bremer silt loam may be increased thru special methods of soil treatment. The installation of tile to improve the drainage conditions is of particular importance. Small applications of manure would be of value on newly drained areas in order to stimulate decomposition and permit of the greater production of available plant food. The type is acid in reaction and would respond to applications of lime. The use of a phosphate fertilizer would undoubtedly prove of value and tests of acid phosphate and rock phosphate are recommended.

#### WAUKESHA LOAM (60)

The Waukesha loam is a minor type in the county, covering 0.4 per cent of the total area. It occurs in numerous small areas on the terraces along the Skunk River, North Skunk River, Indian Creek and some of the minor streams and drainageways of the county. There are no large individual areas of the type. The most extensive areas are northwest and southeast of Reasnor.

The surface soil of the Waukesha loam is a dark brown friable loam, extending to a depth of 15 inches. Below that point it is a lighter brown in color and silty in texture. The subsoil is a brown to yellowish-brown or yellow silt loam to silty clay, becoming lighter in color and heavier in texture at the lower depths.

In topography the Waukesha loam is flat to sloping or very gently undulating. The natural drainage of the type is good. The soil is not drouthy. It occurs on terraces 5 to 15 feet above the flood plains.

Practically all of the Waukesha loam is under cultivation, general farm crops

being grown. Corn yields 40 to 60 bushels per acre, oats 35 to 50 bushels, clover and timothy hay 1 to 2 tons per acre.

The needs of this type to make it more satisfactorily productive, include the application of farm manure in liberal amounts, the turning under of leguminous crops as green manures, the application of lime and the addition of a phosphate fertilizer. The application of farm manure brings about large crop increases on this soil, and leguminous green manures are also of large value. The type is acid and the addition of lime is very necessary, especially for the best growth of legumes. Tests of acid phosphate and rock phosphate are recommended as there are indications that the type will respond in a very large way to applications of a phosphate fertilizer.

#### WAUKESHA SILT LOAM (75)

The Waukesha silt loam is a minor type in the county, covering only 0.4 per cent of the total area. It occurs on the terraces along the Skunk River and Indian Creek, in many small irregular-shaped areas, varying in size from 10 to 275 acres. The most extensive area is found a mile and a half west of Goddard on the west side of Indian Creek.

The surface soil of the Waukesha silt loam is a dark brown to very dark brown silt loam, extending to a depth of 15 inches. The upper subsoil to a depth of 24 inches is a brown, heavy silt loam, changing to a lighter brown silty clay at 24 inches. Below this point the lower subsoil is a yellowish-brown to yellow friable silty clay loam to clay loam somewhat lighter in color in the lower depths. In some areas the dark surface soil extends to greater depths, but the type is generally quite uniform over the country.

In topography the Waukesha silt loam is very gently undulating to flat. It occurs on terraces 5 to 15 feet above overflow and the natural drainage of the soil is good.

Practically all of the type is under cultivation, general farm crops being grown. Corn yields 40 to 60 bushels per acre; oats, 35 to 50 bushels; clover and timothy hay, 1 to 2 tons per acre.

The type will respond in a very large way to applications of farm manure as has been indicated by some experimental work and much experience. Liberal amounts of manure are desirable on this soil. The turning under of leguminous crops as green manures would frequently prove of value also. The type is acid and will respond to applications of lime. The addition of a phosphate fertilizer would be of considerable value as has been shown by some field experiments. Whether rock phosphate or acid phosphate should be employed has not yet definitely been determined. Tests of both carriers are therefore recommended on individual farms.

#### BUCKNER LOAM (38)

The Buckner loam is a minor type in the county, covering 0.2 per cent of the total area. It occurs in a number of small areas on the terraces along the Skunk River. There are no large occurrences of the type. The largest individual area is southwest of Valeria.

The surface soil of the Buckner loam is a dark brown friable loam, extending to a depth of 12 inches. The subsoil is a brown to somewhat lighter brown loam, more sandy in texture than the surface soil and becoming lighter in color in the lower part of the subsoil.

The Buckner loam occurs on terraces 5 to 10 feet above the present flood plain. The natural drainage of the soil is good. The soil is not drouthy except in seasons of unusual dryness. Practically all of the type is under cultivation and general farm crops are grown. Corn yields 35 to 45 bushels per acre; oats, 30 to 40 bushels; and hay, 1 to 1½ or 2 tons.



The chief need of the Buckner loam is for the incorporation of organic matter. Liberal amounts of farm manure should be employed and leguminous crops should be turned under as green manure to build up the content of organic matter and improve the soil conditions so that crops will resist drouth. The type is acid and will respond to applications of lime. The use of a phosphate fertilizer would be very desirable and tests of acid phosphate on the type are recommended.

#### BUCKNER FINE SANDY LOAM (45)

The Buckner fine sandy loam is a minor type in the county, covering only 0.1 per cent of the total area. It is developed in a number of small areas along the Skunk River, the largest development being northwest of Mingo.

The surface soil of the Buckner fine sandy loam is a dark brown to very dark brown mellow, fine sandy loam, extending to a depth of 12 to 16 inches. The subsoil is a friable fine sandy loam somewhat lighter in color than the surface soil. In the area occurring in Sections 3 and 4 of Poweshiek Township the subsoil below 26 to 28 inches is a yellowish-brown to yellow sandy loam containing some very fine gravel.

The type occurs on terraces a few feet above overflow. The natural drainage of the soil is good. It is all under cultivation and general field crops are grown. Yields in normal seasons are quite satisfactory. Some garden and truck crops are grown on the soil and it is very well adapted for such crops.

The type will respond in a very large way to applications of organic matter and liberal amounts of farm manure should be employed. The turning under of a green manure crop will also be of large value. The soil is acid and applications of lime are very desirable for the best growth of general farm crops, and particularly of legumes. The use of a phosphate fertilizer would undoubtedly be of value and tests of acid phosphate are recommended. Where truck crops are grown the use of a complete commercial fertilizer, especially designed for the growth of truck crops, would undoubtedly prove of considerable value.

#### O'NEILL LOAM (108)

The O'Neill loam is a minor type in the county, covering only 0.1 per cent of the total area. It occurs in a number of small areas along Indian Creek in Clear Creek Township.

The surface soil of the type is a dark brown friable loam, extending to a depth of 10 to 14 inches. The subsoil is a sandy loam approaching a loamy sand to sand at depths of 20 to 24 inches. Below this point the subsoil is somewhat variable but generally consists of an incoherent sand.

Usually some gravel occurs in the lower part of the three-foot section. In some areas there is a considerable amount of fine sand in the surface soil. In the area south of Indian Creek on the Polk County line the subsoil below 14 inches is a brown loamy sand, grading into a mixture of fine gravel and sand at 24 inches.

In topography the O'Neill loam is flat to very gently undulating. Drainage is good to excessive. Crops are apt to suffer in periods of drouth. Most of the type is under cultivation. Small areas, however, are utilized for pasture.

The chief need of the O'Neill loam to make it more productive is for the addition of organic matter. Liberal amounts of farm manure should be supplied. The turning under of leguminous crops for green manures would also be of considerable help. The increase in the organic matter content of this soil would reduce the danger of crops suffering from drouth. The type is acid and in need of lime. The use of a phosphate fertilizer would undoubtedly prove of value and tests of acid phosphate are recommended.

## BUCKNER FINE SAND (46)

The Buckner fine sand is a minor type in the county, covering 0.1 percent of the total area. It occurs in several small areas along the North Skunk River and the Skunk River, chiefly in the southeastern part of the county.

The surface soil of the Buckner fine sand is a brown to dark brown fine sand, extending to a depth of about 17 inches. The subsoil is an incoherent, somewhat lighter colored fine sand. In some areas the surface soil is a lighter brown in color and the subsoil is a yellowish-brown to yellow fine sand. Some of these lighter colored areas which occur on knolls are found in Sections 1 and 2 of Lynn Grove Township and in Sections 4 and 16 of Richmond Township.

In topography, the Buckner fine sand is flat to undulating. The drainage is good to excessive. Much of the soil is utilized for pasture. Some is under cultivation, corn, oats and wheat being the chief crops grown. Crop yields are rather low and crops are apt to suffer in dry seasons.

The type is particularly in need of organic matter and liberal amounts of farm manure should be applied. The turning under of leguminous crops as green manures would also be of large value. The soil is acid and would respond to applications of lime. It would also undoubtedly be profitable to employ a phosphate fertilizer and tests of acid phosphate are recommended.

## O'NEILL FINE SAND (146)

The O'Neill fine sand is a minor type in the county, covering only 0.1 percent of the total area. It occurs in several small areas from 10 to 30 acres in size on the terraces along the Skunk River and Indian Creek.

The surface soil of the O'Neill fine sand is a brown to dark brown fine sand. The subsoil, below 10 inches, is a grayish to yellowish-brown incoherent fine sand, containing some gravel. Gravel sometimes appears also on the surface soil. In some areas the surface soil is somewhat darker in color. In places there is no gravel within the three-foot section and the subsoil is a yellowish incoherent fine sand. In the area lying in Section 17, Clear Creek Township and in the one on the line between Section 17 and 20 of the same township, the soil varies somewhat from the typical O'Neill fine sand. Here the surface soil is darker in color and varies in texture from a fine sand to a loamy fine sand or a light textured fine sandy loam. The subsoil is generally a fine sand or loamy fine sand and lighter in color than the surface soil.

Most of the O'Neill fine sand is under cultivation and general farm crops are grown. The yields are usually low and crops are apt to suffer in periods of drouth.

The needs of this soil are for the incorporation of organic matter and liberal applications of farm manure are very desirable. The use of a leguminous crop as a green manure would also be of large value. The type is acid and in need of lime. The application of a phosphate fertilizer would undoubtedly prove of value and tests of acid phosphate are recommended. Truck crops would undoubtedly do very well on this soil and when such crops are grown the use of a complete commercial fertilizer might prove of large value.

## CHARITON SILT LOAM (105)

The Chariton silt loam is a minor type in the county, covering only 0.1 percent of the total area. It occurs in four areas along the Skunk River and the North Skunk River. One area is five miles northwest of Reasnor; the second, 2½ miles west of Reasnor; the third, three miles southeast of Kellogg; and the fourth, ½ mile northwest of Lynnville.

The surface soil of the Clarion silt loam is a dark grayish-brown smooth silt loam. The upper subsoil, from 12 to 20 inches, is an ashy gray flour-like silt



loam. The subsoil at 20 inches is a drab or gray heavy clay loam, changing into a heavy waxy tenacious clay, bluish-gray in color and mottled with lighter gray. Some areas in the lower subsoil are mottled with yellow and brown and stains of iron.

The type is all under cultivation, corn, hay and oats being the chief crops grown. Yields of these crops are generally fairly satisfactory. The chief needs of the soil to make it productive are for adequate drainage, the incorporation of organic matter, the addition of lime and the application of a phosphate fertilizer.

### SWAMP AND BOTTOMLAND SOILS

There are six swamp and bottomland soils in the county and these with the area of peat and muck make a total of seven areas of bottomland soils. Together they cover 13.7 per cent of the total area of the county.

#### WABASH SILT LOAM (26)

The Wabash silt loam is the most extensive bottomland soil and the fourth largest individual type in the county, covering 7.6 per cent of the total area. It occurs in many extensive areas on the bottoms in all parts of the county. Along the larger creeks, Skunk River and North Skunk River, the areas are larger and the type is more important. Along smaller streams the soil occurs in narrow irregular-shaped areas and is of less importance agriculturally. The largest areas of the type are developed along the Skunk River and Indian Creek thru Palo Alto, Mound Prairie and Sherman Townships. A considerable development of the type is also found in Clear Creek, Poweshiek and Washington Townships and along the North Skunk River in Lynn Grove and Malaka Townships.

The surface soil of the Wabash silt loam is a very dark grayish-brown to nearly black silt loam, extending to a depth of 16 inches. The upper subsoil is a heavy silt loam, changing gradually into a dark drab silty clay to heavy clay loam at a depth of 24 inches. The lower subsoil is a drab to gray clay loam to clay, mottled with brown and yellow and generally containing iron stains and concretions. In some areas the brown and yellow color occur to a large extent in the lower subsoil. In other places the subsoil may be a solid gray in color with practically no mottlings. In some of the narrower areas along the minor streams, the subsoil below 30 inches is a grayish fine sand or loamy fine sand. Within the type are included a few small areas of riverwash along the Skunk River and Indian Creek. These are too small to separate out on the map. In some areas where the type occurs adjacent to upland soils which are light in color, there are spots where the surface soil is a light colored silty soil to a depth of one to three inches, underlaid by the dark colored soil of the type. These areas are formed from the wash from the upland over the Wabash silt loam on the bottoms.

In topography the Wabash silt loam is flat to sloping, drainage is generally good but in some areas it is not adequate. The straightening of some streams and the installation of surface ditches and tile drains have increased the drainage of the type and also reduced the frequency of overflows. On the more extensive areas the type is overflowed very irregularly.

The small areas of the soil along the small streams are generally pastured. The larger areas of the type are cultivated and are used for general farm crops. Corn yields 40 to 75 bushels per acre; oats, 40 to 65 bushels; and clover, 2 tons or more per acre.

The need of the Wabash silt loam for satisfactory crop growth is chiefly for protection from overflow and thoro drainage. When this is accomplished rather satisfactory crop yields are generally secured. The application of small amounts of farm manure would be of value on newly drained areas but this material

should not be applied preceding the growth of the small grain crop. The type is acid in reaction and the application of lime would be of value for the best growth of legumes. The application of a phosphate fertilizer might also prove of value and tests of acid phosphate and rock phosphate are recommended.

#### WABASH SILTY CLAY LOAM (48)

The Wabash silty clay loam is the second largest bottomland soil but a minor type in the county. It covers 5.0 per cent of the total area. It is developed mainly along the Skunk River and the North Skunk River and Indian Creek. Areas are also found along Clear Creek, Cherry Creek, Alloway and Rock Creeks. A large continuous area of the type extends along Skunk River from the Marion County line north as far as Metz. Another extensive area occurs along this river north and extending to the east and west of Colfax. The areas along Indian Creek, North Skunk River, and some of the minor streams of the county are less extensively developed.

The surface soil of the Wabash silty clay loam is a very dark gray or dark brown to black silty clay loam, extending to a depth of about 16 inches. The subsoil is a dark drab heavy clay loam, grading into a drab clay, mottled with gray and some brown and yellow. In some areas the surface soil is a heavy silty clay loam and occasionally it is a clay loam. A few small spots of the Wabash clay are included but these are too small to separate out on the map.

In topography the Wabash silty clay loam is flat to sloping, being depressed in some areas. Drainage is generally deficient in the type. In some areas the surface soil is rather uneven in topography and here the texture is lighter. Included within the Wabash silty clay loam are small areas of riverwash which are not sufficiently large to show on the map.

The greater part of the Wabash silty clay loam is subject to overflow only infrequently. Some areas are seldom overflowed, others are flooded only at long intervals. The course of the Skunk River has been dredged and straightened and this has reduced the frequency of flooding. The installation of open ditches and the laying of tile lines has also improved conditions on these bottomland soils.

The greater part of the Wabash silty clay loam is utilizable for the growth of cultivated crops. In some small areas close to the present stream courses, the surface is more or less cut up by branches of the streams. These areas are usually occupied by trees and brush. Some of this land supports a good growth of grasses and is utilized for pasture purposes. Some areas are low and subject to flooding regularly. These are utilized for pasture purposes only, supporting a growth of wild grass. On the cultivated areas general farm crops are grown. Corn yields 40 to 70 bushels per acre and in favorable seasons the yields may go as high as 80 or 90 bushels. Oats yield 35 to 65 bushels and hay, 2 to 2½ tons per acre.

The chief need of the Wabash silty clay loam to make it more productive is for more adequate drainage and in some cases for protection from overflow. When the land is well drained, small applications of farm manure would be of value in stimulating the production of available plant food. Large amounts of manure should not be applied preceding growth of a small grain crop. The type is acid and in need of lime. Applications of phosphate fertilizers would also undoubtedly be of value and tests of rock phosphate and acid phosphate are recommended.

#### WABASH LOAM (49)

The Wabash loam is a minor type in the county, covering only 0.6 per cent of the total area. It occurs mainly along Indian Creek and the Skunk River. A few areas occur along the North Skunk River. The large development of the



type is along Indian Creek north of Mingo. Most of the areas are small. The surface soil of the Wabash loam is a very dark brown, mellow, friable loam, somewhat silty in places, extending to a depth of 16 to 18 inches. The subsoil is a dark drab to gray or mottled gray, brown and yellow heavy loam to silty clay or sandy clay in the lower part of the three-foot section. In some areas the subsoil is a heavy loam somewhat lighter in color than the surface soil.

In topography the Wabash loam is generally flat, drainage is good, but a part of the land is subject to overflow. The type is largely under cultivation, some areas being utilized for pasture land. General farm crops are grown and the yields are somewhat lower than those secured on the heavier textured Wabash types. The needs of this soil to make it more productive include the application of manure, the addition of lime and probably the application of a phosphate fertilizer. Tests of acid phosphate and rock phosphate would be very desirable.

#### WABASH CLAY (72)

The Wabash clay is a minor type in the county, covering only 0.3 per cent of the total area. It occurs mainly along the Skunk River in a number of small areas. There are other minor developments of the type along Indian Creek and Elk Creek.

The surface soil of the Wabash clay is a very dark brown to black sticky and tenacious clay, extending to a depth of about 18 inches. The subsoil is a dark drab clay becoming a lighter gray in color in the lower part, very heavy in texture and containing some iron concretions. In topography the type is flat to depressed and the natural drainage is poor.

The soil is utilized mainly for pasture and for the production of wild hay. Where it occurs along stream banks it is subject to flooding at frequent intervals and water stands for some time on the surface of the soil. In isolated areas back from the stream banks, water from floods and heavy rains is so slowly removed that the areas become swampy and often support a growth of water-loving plants. Surface ditches have been installed in some places and these aid in the removal of excess moisture.

If the Wabash clay is to be cultivated, its first need is for adequate drainage and protection from overflow. When this is accomplished, very satisfactory crop yields may be secured as the type is naturally high in fertility. Small amounts of farm manure would be of value on newly drained areas. The addition of lime would help the growth of legumes as the type is acid and the application of a phosphate fertilizer would undoubtedly prove of value.

#### WABASH FINE SANDY LOAM (62)

The Wabash fine sandy loam is a minor type in the county, covering only 0.1 per cent of the total area. Four small areas of the type were mapped along the Skunk River, the two larger areas being found south and southwest of Valeria.

The surface soil of the Wabash fine sandy loam is a dark brown to very dark brown fine sandy loam, extending to a depth of 16 inches. The subsoil is a grayish-brown loam or silt loam to light silty clay loam, changing at 24 inches into a mottled gray, brown and yellow heavy clay loam.

The type supports a good growth of native grasses, bluegrass or timber and brush. In 1921, three of the areas were in pasture, one was under cultivation.

If the type is to be cultivated, it needs first of all to be protected from overflow. When this is accomplished, very satisfactory crop yields may be secured. Applications of farm manure would be of value, the type is acid, and lime should be applied as needed for the best growth of legumes. The use of a phosphate fertilizer would also undoubtedly prove of value.

## PEAT AND MUCK (21)

There is a very small area of peat and muck in the county, covering together less than one-tenth of one per cent of the area. The two materials have been mapped together because of the small extent of the areas and because they are largely intermixed when they occur.

Peat consists of an accumulation of plant residues in areas which were originally covered with water, supporting a luxuriant growth of water-loving plants. The plant remains accumulated in the bottoms of these ponds and when the water was finally drained from the areas there remained an accumulation of undecayed plant residues which has a characteristic brown color and is known as peat. When decomposition has proceeded to some extent, and the color has been changed to a black and the original form of the plant roots, stems and leaves has disappeared, there is formed what is known as muck.

The areas of peat and muck usually consist of these plant materials to a depth of three feet or less and the underlying material is a black mucky silty clay loam. In places in Jasper County the heavy textured subsoil is found at the depth of 24 to 30 inches.

The chief need of these areas if they are to be reclaimed and made productive is for adequate drainage. When this is accomplished the areas should be properly plowed and cultivated. Deep plowing is desirable and fall plowing is of large value. It is then recommended that the land be seeded down to timothy and alsike clover and utilized for pasture purposes so that the tramping of the animals will make the peat more compact and firm. Some truck crops are occasionally grown very successfully on peat and muck areas. Potatoes, celery, onions, and tomatoes do very well.

## LAMOURE SILTY CLAY LOAM (111)

There is one small area of the Lamoure silty clay loam in the western part of Section 30 of Clear Creek Township. It occupies less than one-tenth of one per cent of the area of the county.

The surface soil of the Lamoure silty clay loam is a black to very dark brown silty clay loam. The subsoil is a black to dark drab heavy clay loam to clay. The color becomes a lighter gray at the lower depths as the clay content increases. The subsoil contains lime and effervesces freely with acid.

The type is subject to overflow and water stands on it after periods of heavy rain. It is utilized for permanent pasture and supports a good growth of bluegrass. If it is to be cultivated it will need first of all to be protected from overflow, and thoro drainage will need to be established. When this is accomplished, good crop yields may be secured. It would respond to small applications of farm manure when newly drained and the addition of a phosphate fertilizer would undoubtedly prove of considerable value.





are emphasized as necessary or their discontinuance advised, and new methods of proven value are suggested.

#### PLANT FOOD IN SOILS

Fifteen different chemical elements are essential for plant food, but many of these occur so extensively in soils and are used in such small quantities that there is practically no danger of their ever running out. Such, for example, is the case with iron and aluminum, past experience showing that the amount of these elements in the soil remains practically constant.

Furthermore, there can never be a shortage in the elements which come primarily from the air, such as carbon and oxygen, for the supply of these in the atmosphere is practically inexhaustible. The same is true of nitrogen, which is now known to be taken directly from the atmosphere by well-inoculated legumes and by certain microscopic organisms. Hence, altho many crops are unable to secure nitrogen from the air and are forced to draw on the soil supply, it is possible by the proper and frequent growing of well-inoculated legumes and their use as green manures, to store up sufficient of this element to supply all the needs of succeeding non-legumes.

#### THE "SOIL DERIVED" ELEMENTS

Phosphorus, potassium, calcium and sulfur, known as "soil derived" elements, may frequently be lacking in soils, and then a fertilizing material carrying the necessary element must be used. Phosphorus is the element most likely to be deficient in all soils. This is especially true of Iowa soils. Potassium frequently is lacking in peats and swampy soils, but normal soils in Iowa and elsewhere are usually well supplied with this element. Calcium may be low in soils which have borne a heavy growth of a legume, especially alfalfa; but a shortage of this element is very unlikely. It seems possible from recent tests that sulfur may be lacking in many soils, for applications of sulfur fertilizers have proved of value in some cases. However, little is known as yet regarding the relation of this element to soil fertility. If later studies show its importance for plant growth and its deficiency in soils, sulfur fertilizers may come to be considered of much value.

#### AVAILABLE AND UNAVAILABLE PLANT FOOD

Frequently a soil analysis shows the presence of such abundance of the essential plant foods that the conclusion might be drawn that crops should be properly supplied for an indefinite period. However, applications of a fertilizer containing one of the elements present in such large quantities in the soil may bring about an appreciable and even profitable increase in crops.

The explanation of this peculiar state of affairs lies in the fact that all the plant food shown by analysis to be present in soils is not in a usable form; it is said to be *unavailable*. Plants cannot take up food unless it is in solution; hence *available* plant food is that which is in solution. Analyses show not only this soluble or available portion, but also the very much larger insoluble or unavailable part. The total amount of plant food in the soil may, therefore, be abundant for numerous crops, but if it is not made available enough, plants will suffer for proper food.

Bacteria and molds are the agents which bring about the change of insoluble, unavailable material into available form. If conditions in the soil are satisfactory for their vigorous growth and sufficient total plant food is present, these organisms will bring about the production of enough soluble material to support good crop growth.

#### REMOVAL OF PLANT FOOD BY CROPS

The decrease of plant food in the soil is the direct result of removal by crops, altho there is often some loss by leaching also. A study of the amounts of nitrogen, phosphorus, and potassium removed by some of the common farm crops will show how rapidly these elements are used up under average farming conditions.

The amounts of these elements in various farm crops are given in table I. The amount of calcium and sulfur in the crops is not included, as it is only recently that the removal of these elements has been considered important enough to warrant analyses.

The figures in the table show also the value of the three elements contained in the different crops, calculated from the market value of fertilizers containing them. Thus the value of nitrogen is figured at 16 cents per pound, the cost of the elements in nitrate of soda; phosphorus at 12 cents, the cost in acid phosphate, and potassium at 6 cents, the cost in muriate of potash.



TABLE I. PLANT FOOD IN CROPS AND VALUE

Calculating Nitrogen (N) at 16c (Sodium Nitrate ( $\text{Na NO}_3$ )), Phosphorus (P) at 12c (Acid Phosphate), and Potassium (K) at 6c (Potassium Chloride ( $\text{KC1}$ ))

Crop	Yield	Plant food, lbs.			Value of plant food			Total value of plant food
		Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium	
Corn, grain.....	75 bu.	75	12.75	14	\$12.00	\$1.52	\$0.84	\$14.37
Corn, stover.....	2.25 T.	36	4.5	39	5.76	0.54	2.34	8.64
Corn, crop.....		111	17.25	53	17.76	2.07	3.18	23.01
Wheat, grain....	30 bu.	42.6	7.2	7.8	6.81	0.86	0.46	8.13
Wheat, straw....	1.5 T.	15	2.4	27	2.40	0.28	1.62	4.30
Wheat, crop.....		57.6	9.6	34.8	9.21	1.14	2.08	12.43
Oats, grain.....	50 bu.	33	5.5	8	5.28	0.66	0.48	6.42
Barley, straw....	1.25 T.	15.5	2.5	26	2.48	0.30	1.56	8.28
Oats, crop.....		48.5	8	34	7.76	0.96	2.04	14.70
Barley, grain....	30 bu.	23	5	5.5	3.68	0.60	0.33	4.61
Barley, straw....	0.75 T.	9.5	1	13	1.52	0.12	0.78	2.42
Barley, crop.....		32.5	6	18.5	5.20	0.72	1.11	7.03
Rye, grain.....	30 bu.	29.4	6	7.8	4.70	0.72	0.46	5.88
Rye, straw.....	1.5 T.	12	3	21	1.92	0.36	1.26	3.54
Rye, crop.....		41.4	9	28.8	6.62	1.08	1.72	9.42
Potatoes.....	300 bu.	63	12.7	90	10.08	1.25	5.40	17.00
Alfalfa, hay.....	6 T.	300	27	144	48.00	3.24	8.64	59.88
Timothy, hay....	3 T.	72	9	67.5	11.52	1.08	3.95	16.55
Clover, hay.....	3 T.	120	15	90	19.20	1.80	5.40	16.40

It is evident from the table that the continuous growth of any common farm crop without returning these three important elements will lead finally to a shortage of plant food in the soil. The nitrogen supply is drawn on the most heavily by all the crops, but in the case of alfalfa and clover only a small part should be taken from the soil. If these legumes are inoculated as they should be, they will take most of their nitrogen from the atmosphere. The figures are therefore entirely too high for the nitrogen taken from the soil by these two crops, but the loss of nitrogen from the soil by removal in non-leguminous crops is considerable. The phosphorus and potassium in the soil are also rapidly reduced by the growth of ordinary crops. While the nitrogen supply may be kept up by the use of leguminous green manure crops, phosphorus and potassium must be supplied by the use of expensive commercial fertilizers.

The cash value of the plant food removed from soils by the growth and sale of various crops is considerable. Even where the grain alone is sold and the crop residues are returned to the soil, there is a large loss of fertility, and if the entire crop is removed and no return made, the loss is almost doubled. It is evident, therefore, that in calculating the actual income from the sale of farm crops, the value of the plant food removed from the soil should be subtracted from the proceeds at least in the case of constituents which must be replaced at the present time.

Of course, if the crops procured are fed on the farm and the manure carefully preserved and used, a large part of the valuable matter in the crops will be returned to the soil. This is the case in livestock and dairy farming where the products sold contain only a portion of the valuable elements of plant food removed from the soil. In grain farming, however, green manure crops and commercial fertilizers must be depended upon to supply plant food deficiencies in the soil. It should be mentioned that the proper use of crop residues in this latter system of farming reduces considerably plant food loss.

#### REMOVAL FROM IOWA SOILS

It has been conservatively estimated that the plant food taken from Iowa soils and shipped out of the state in grain amounts to about \$30,000,000 annually. This calculation is based on the estimate of the secretary of the Western Grain Dealers' Association that 20 per cent of the corn and 35 to 40 per cent of the oats produced in the state is shipped off the farms.

This loss of fertility is unevenly distributed over the state, varying, as farmers do more or less livestock and dairy farming or grain farming. In grain farming, where no manure is produced and the entire grain crop is sold, the soil may very quickly become deficient in certain necessary plant foods. Eventually, however, all soils are depleted in essential food materials, whatever system of farming is followed.

### PERMANENT FERTILITY IN IOWA SOILS

The preliminary study of Iowa soils, already reported, revealed the fact that there is not an inexhaustible supply of nitrogen, phosphorus and potassium in the soils of the state. Potassium was found in much larger amounts than the other two elements, and it was concluded, therefore, that attention should be centered at the present time on nitrogen and phosphorus. In spite of the fact that Iowa soils are still comparatively fertile and crops are still large there is abundant evidence at hand to prove that the best possible yields of certain crops are not being obtained in many cases because of the lack of necessary plant foods or because of the lack of proper conditions in the soil for the growth of plants and production, by bacteria, of available plant food.

Proper systems of farming will insure the production of satisfactory crops and the maintenance of permanent fertility and the adoption of such systems should not be delayed until the crop yields are much lower, for then it will involve a long, tedious and very expensive fight to bring the soil back to a fertile condition. If proper methods are put into operation while comparatively large amounts of certain plant foods are still present in the soil, it is relatively easy to keep them abundant and attention may be centered on other elements likely to be limiting factors in crop production.

Soils may be kept permanently fertile by adopting certain practices which will be summarized here.

### CULTIVATION AND DRAINAGE

Cultivation and drainage are two of the most important farm operations in keeping the soil in a favorable condition for soil production, largely because they help control the moisture in the soil.

The moisture in soils is one of the most important factors governing crop production. If the soil is too dry, plants suffer for lack of water necessary to bring them their food and also for lack of available plant food. Bacterial activities are so restricted in dry soils that the production of available plant food practically ceases. If too much moisture is present, plants likewise refuse to grow properly because of the exclusion of air from the soil and the absence of available food. Decay is checked in the absence of air, all beneficial bacterial action is limited and humus, or organic matter, containing plant food constituents in an available form, accumulates. The infertility of low-lying, swampy soils is a good illustration of the action of excessive moisture in restricting plant growth by stopping aeration and limiting beneficial decay processes.

While the amount of moisture in the soil depends very largely on the rainfall, any excess of water may be removed from the soil by drainage and the amount of water present in the soil may be conserved during the periods of drouth by thoro cultivation or the maintaining of a good mulch. The need for drainage is determined partly by the nature of the soil, but more particularly by the subsoil. If the subsoil is a heavy, tight clay, a surface clay loam will be rather readily affected by excessive rainfall. On the other hand, if the surface soil is sandy, a heavy subsoil will be of advantage in preventing the rapid drying out of the soil and also in checking losses of valuable matter by leaching.

### THE ROTATION OF CROPS

Experience has shown many times that the continuous growth of one crop takes the fertility out of a soil much more rapidly than a rotation of crops. One of the most important farm practices, therefore, from the standpoint of soil fertility, is the rotation of crops on a basis suited to the soil, climatic, farm and market conditions. The choice of crops is so large that no difficulty should be experienced in selecting those suitable for all conditions.

There is a third explanation of the value of rotations. It is claimed that crops in their growth produce certain substances called "toxic" which are injurious to the same crop, but have no effect on certain other crops. In a proper rotation the time between two different crops of the same plant is long enough to allow the "toxic" substance to be disposed of in the soil or made harmless. This theory has not been commonly accepted, chiefly because of the lack of confirmatory evidence. It seems extremely doubtful if the amounts of these "toxic" substances could be large enough to bring about the effects evidenced in continuous cropping.

But, whatever the reason for the bad effects of continuous cropping, it is evident that for all good systems of farming some definite rotation should be adopted, and that rotations should always contain a legume, because of the value of such crops to the soil. In no other way can the humus and nitrogen content of soils be kept up so cheaply and satisfactorily as by the use of legumes, either as regular or "catch" crops in the rotation.



## MANURING

There must always be enough humus, or organic matter, and nitrogen in the soil if satisfactory crops are to be secured. Humus not only keeps the soil in the best physical condition for crop growth, but it supplies a considerable portion of nitrogen. An abundance of humus may always be considered a reliable indication of the presence of much nitrogen. This nitrogen does not occur in a form available for plants, but with proper physical conditions in the soil, the unusable nitrogen in the animal and vegetable matter which makes up the humus, is made usable by numerous bacteria and changed into soluble and available nitrates.

The humus, or organic matter, also encourages the activities of many other bacteria which produce carbon dioxide and various acids which dissolve and make available the insoluble phosphorus and potassium in the soil.

Three materials may be used to supply the organic matter and nitrogen of soils. These are farm manure, crop residues and green manure, the first two being much more common.

By using all the crop residues, all the manure produced on the farm, and giving well-inoculated legumes a place in the rotation for green manure crops, no artificial means of maintaining the humus and nitrogen content of soils need be resorted to.

## THE USE OF PHOSPHORUS

Iowa soils are not abundantly supplied with phosphorus. Moreover, it is possible by the use of manures, green manures, crop residues, straw, stover, etc., to return to the soil the entire amount of that element removed by crops. Crop residues, stover and straw merely return a portion of the phosphorus removed, and while their use is important in checking the loss of the element, they cannot stop it. Green manuring adds no phosphorus that was not used in the growth of the green manure crop. Farm manure returns part of the phosphorus removed by crops which are fed on the farm, but not all of it. While, therefore, immediate scarcity of phosphorus in Iowa soils cannot be positively shown, analyses and results of experiments show that in the more or less distant future, phosphorus must be applied or crops will suffer for a lack of this element. Furthermore, there are indications that its use at present would prove profitable in some instances.

Phosphorus may be applied to soils in three commercial forms, bone meal, acid phosphate and rock phosphate. Bone meal cannot be used generally, because of its extremely limited production, so the choice rests between rock phosphate and acid phosphate. Experiments are now under way to show which is more economical for farmers in the state. Many tests must be conducted on a large variety of soil types, under widely differing conditions, and thru a rather long period of years. It is at present impossible to make these experiments as complete as desirable, owing to small appropriations for such work, but the results secured from the tests now in progress will be published from time to time in the different county reports.

Until such definite advice can be given for individual soil types, it is urged that farmers who are interested make comparisons of rock phosphate and acid phosphate on their own farms. In this way they can determine at first hand the relative value of the two materials. Information and suggestions regarding the carrying out of such tests may be secured upon application to the Soils Sections.

## LIMING

Practically all crops grow better on a soil which contains lime, or in other words, on one which is not acid. As soils become acid, crops grow smaller, bacterial activities are reduced and the soil becomes infertile. Crops are differently affected by acidity in the soil; some refuse to grow at all; others grow but poorly. Only in a very few instances can a satisfactory crop be secured in the absence of lime. Therefore, the addition of lime to soils in which it is lacking is an important principle in permanent soil fertility. All soils gradually become acid because of the losses of lime and other basic materials thru leaching and the production of acids in the decomposition process constantly occurring in soils. Iowa soils are no exceptions to the general rule, as was shown by the tests of many representative soils reported in Bulletin No. 151 of this station. Particularly are the soils in the Iowan drift, Mississippi loess and Southern Iowa loess areas likely to be acid.

All Iowa soils should therefore be tested for acidity before the crop is seeded, particularly when legumes, such as alfalfa or red clover, are to be grown. Any farmer may test his own soil and determine its need of lime, according to simple directions in bulletin No. 151, referred to above.

As to the amount of lime needed for acid soils as a general rule sufficient should be applied to neutralize the acidity in the surface soil and then an additional amount of one or two tons per acre.

## SOIL AREAS IN IOWA

There are five large soil divisions in Iowa, the Wisconsin drift, the Iowan drift, the Missouri loess, the Mississippi loess and the Southern Iowa loess. These five divisions of the soils of the state are based on the geological forces which brought about the formation of the various soil areas. The various areas are shown in the map, fig. 14.

With the exception of the northeastern part of the state, the whole surface of Iowa was in ages past overrun by the great continental ice sheets. These great masses of ice moved slowly over the land, crashing and grinding the rocks beneath and carrying along with them the material which they accumulated in their progress. Five ice sheets invaded Iowa at different geological eras, coming from different directions and carrying therefore, different rock material with them.

The deposit, or sheet, of earth debris left after the ice of such glaciers melts is called "glacial till" or "drift" and is easily distinguished by the fact that it is usually a rather stiff clay containing pebbles of all sorts as well as large boulders or "nigger" heads." Two of these drift areas occur in Iowa today, the Wisconsin drift and the Iowan drift, covering the north central part of the state. The soils of these two drift areas are quite different in chemical composition, due primarily to the different ages of the two ice invasions. The Iowan drift was laid down at a much earlier period and is somewhat poorer in plant food than the Wisconsin drift soil, having undergone considerable leaching in the time which has elapsed since its formation.

The drift deposits in the remainder of the state have been covered by so-called loess soils, vast accumulations of dust-like materials which settled out of the air during a period of geological time when climatic conditions were very different than at present. These loess soils are very porous in spite of their fine texture and they rarely contain large pebbles or stones. They present a strong contrast to the drift soils, which are somewhat heavy in texture and filled with pebbles and stones. The three loess areas in the state, the Missouri, the Mississippi and the Southern Iowa, are distinguished by differences in texture and appearance, and they vary considerably in value for farming purposes. In some sections the loess is very deep, while in other places the underlying leached till or drift soil is very close to the surface. The fertility of these soils and their needs are greatly influenced, therefore, by their depth.

It will be seen that the soils of the state may be roughly divided into two classes, drift soils and loess soils, and that further divisions may then be made into various drift and loess soils because of differences in period of formation, characteristics and general composition. More accurate information demands, however, that further divisions be made. The different drift and loess soils contain large numbers of soil types which vary among themselves, and each of these should receive special attention.

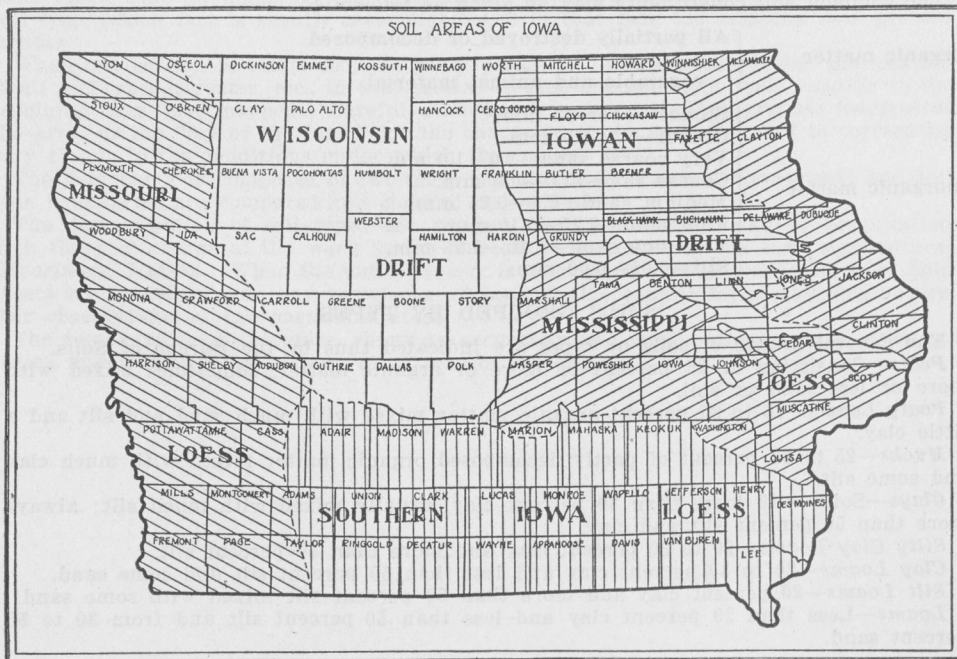


Fig. 14. Map showing principal soil areas in Iowa.



## THE SOIL SURVEY BY COUNTIES

It is apparent that a general survey of the soils of the state can give only a very general idea of soil conditions. Soils vary so widely in character and composition, depending on many other factors than their source, that definite knowledge concerning their needs can be secured only by thoro and complete study of them in place in small areas. Climatic conditions, topography, depth and character of soil, chemical and mechanical composition and all other factors affecting crop production must be considered.

This is what is accomplished by the soil survey of the state by counties, and hence the needs of individual soils and proper systems of management may be worked out in much greater detail and be much more complete than would be possible by merely considering the large areas separated on the basis of their geological origin. In other words, while the unit in the general survey is the geological history of the soil area, in the soil survey by counties or any other small area, the unit is the soil type.

## GENERAL SOIL CHARACTERISTICS

Soil types possess more or less definite characteristics which may be determined largely in the field, altho some laboratory study is necessary for final disposition. Usually the line of separation between adjoining soil types is quite distinct and it is a simple matter to locate the type boundaries. In some cases, however, there is a graduation from one type to another and then the boundaries may be fixed only with great difficulty. The error introduced into soil survey work from this source is very small and need cause little concern.

The factors which must be taken into account in establishing soil types have been well enumerated by the Illinois Experiment Station in its Soil Report No. 1. They are:

1. The geological origin of the soil, whether residual, glacial, loessial, alluvial, colluvial or cumulose.
2. The topography or lay of the land.
3. The structure or depth and character of the surface, subsurface and subsoil.
4. The physical and mechanical composition of different strata composing the soil, as the percentages of gravel, sand, silt, clay and organic matter which they contain.
5. The texture or porosity, granulation, friability, plasticity, etc.
6. The color of the strata.
7. The natural drainage.
8. The agricultural value based upon its natural productiveness.
9. Native vegetation.
10. The ultimate chemical composition and reaction.

The common soil constituents may be given as follows:†

Organic matter	{ All partially destroyed or decomposed vegetable and animal material.
Inorganic matter	{ Stones—over 32 mm.* Gravel—32—2.0 mm. Very coarse sand—2.0—1.0 mm. Coarse sand—1.0—0.5 mm. Medium sand—0.5—0.25 mm. Fine sand—0.25—0.10 mm. Very fine sand—0.10—0.05 mm. Silt—0.05—0.00 mm.

## SOILS GROUPED BY TYPES

The general groups of soils by types are indicated thus by the Bureau of Soils.

*Peats*—Consisting of 35 percent or more of organic matter, sometimes mixed with more or less sand or soil.

*Peaty Loams*—15 to 35 percent organic matter mixed with much sand and silt and a little clay.

*Mucks*—25 to 35 percent of partly decomposed organic matter mixed with much clay and some silt.

*Clays*—Soils with more than 30 percent clay, usually mixed with much silt; always more than 50 percent silt and clay.

*Silty Clay Loams*—20 to 30 percent clay and more than 50 percent silt.

*Clay Loams*—20 to 30 percent clay and less than 50 percent silt and some sand.

*Silt Loams*—20 percent clay and more than 50 percent silt mixed with some sand.

*Loams*—Less than 20 percent clay and less than 50 percent silt and from 30 to 50 percent sand.

\*25 mm. equals 1 in. †Bureau of Soils Book.

*Sandy Clays*—20 percent silt and small amounts of clay up to 30 percent.

*Fine Sandy Loams*—More than 50 percent fine sand and very fine sand mixed with less than 25 percent very coarse sand, coarse sand and medium sand, much silt and a little clay; silt and clay 20 to 50 percent.

*Sandy Loams*—More than 25 percent very coarse, coarse and medium sand; silt and clay 20 to 50 percent.

*Very Fine Sand*—More than 50 percent fine sand and less than 25 percent very coarse, coarse and medium sand, less than 20 percent silt and clay.

*Fine Sand*—More than 50 percent fine sand and less than 25 percent very coarse, coarse and medium sand, less than 20 percent silt and clay.

*Sand*—More than 25 percent very coarse, coarse and medium sand, less than 50 percent fine sand, less than 20 percent silt and clay.

*Coarse Sand*—More than 25 percent very coarse, coarse and medium sand, less than 50 percent of other grades, less than 20 percent silt and clay.

*Gravelly Loams*—25 to 50 percent very coarse sand and much sand and some silt.

*Gravels*—More than 50 percent very coarse sand.

*Stony Loams*—A large number of stones over one inch in diameter.

#### METHODS USED IN THE SOIL SURVEY

It may be of some interest to state briefly the methods which are followed in the field in surveying the soils.

As has been indicated the completed map is intended to show the accurate location and boundaries, not only of all soil types but also of the streams, roads, railroads, etc.

The first step, therefore, is the choice of an accurate base map and any official map of the county may be chosen for this purpose. Such maps are always checked to correspond correctly with the land survey. The location of every stream, road and railroad on the map is likewise carefully verified and corrections are frequently necessary. When an accurate base map is not available the field party must first prepare one.

The section is the unit area by which each county is surveyed and mapped. The distances in the roads are determined by an odometer attached to the vehicle, and in the field by pacing, which is done with accuracy. The directions of the streams, roads, railroads, etc., are determined by the use of the compass and the plane table. The character of the soil types is ascertained in the section by the use of the auger, an instrument for sampling both the surface soil and the subsoil. The boundaries of each type are then ascertained accurately in the section and indicated on the map. Many samplings are frequently necessary, and individual sections may contain several soil types and require much time for mapping. In other cases, the entire section may contain only one soil type, which fact is readily ascertained, and in that case the mapping may proceed rapidly.

When one section is completed, the party passes to the next section and the location of all soil types, streams, etc., in that section is then checked with their location in the adjoining area just mapped. Careful attention is paid to the topographic features of the area, or the "lay of the land," for the character of the soils is found to correspond very closely to the conditions under which they occur.

The field party is composed of two men, and all observations, measurements and soil type boundaries are compared and checked by each man.

The determination of soil types are verified also by inspection and by consultation with those in charge of the work at the Bureau of Soils and at the Iowa Agricultural Experiment Station. When the entire county is completed, all the section maps of field sheets are assembled and any variations or questionable boundaries are verified by further observations of the particular area.

The completed map, therefore, shows as accurately as possible all soils and soil boundaries, and it constitutes also an exact map of the county.